THE TOPOGRAPHY OF THE EXTRAHEPATIC BILIARY PASSAGES*

WITH REFERENCE TO DANGERS OF SURGICAL TECHNIC

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THE anatomy of variations of the biliary passages has long been studied by many investigators and is elucidated in a number of special articles and manuals. We have no intention of repeating facts already described, but wish to dwell upon some supplementary data obtained as a result of observations made on the extrahepatic biliary passages in a series of 194 cadavers (162 adults and 32 children).

I. RELATIONS OF THE GALLBLADDER FUNDUS TO THE LIVER EDGE. In 64 cadavers (33 per cent), the fundus lay 1 to 2 cm. above and behind the anterior margin of the liver (Fig. 1A). Clinically, this supramarginal type of gallbladder fundus, even when distended, would be difficult to palpate. In 27 cadavers (13.9 per cent), the fundus extended down to the anterior margin of the liver (Fig. 1B); and in 103 cadavers (53.1 per cent), it protruded 0.5 to 4 cm. below the margin (Fig. 1C). Obviously, the third or inframarginal variety is clinically the most readily palpable.

II. RELATIONS OF THE POSTERIOR PART OF THE GALLBLADDER AND GALLBLADDER NECK TO THE DUODENOHEPATIC LIGAMENT AND NEIGHBORING STRUCTURES. In 75 cadavers (38.6 per cent), independently of the details of the various forms of the gallbladder, we observed the junction of the posterior part of the gallbladder and cystic duct to be at the posterior end of the gallbladder fossa (Fig. 2A). In this group the posterior portion of the gallbladder, sometimes referred to as the infundibulum or Hartman's pouch, did not touch the hepatoduodenal ligament. In three cadavers (1.6 per cent), the infundibulum extended downwards 1 to 3 cm. parallel and closely adjacent to the right border of the ligament and the vessels contained therein (Fig. 2B). In all of the other cadavers (59.8 per cent), the infundibulum of the variously formed gallbladders overlay at various distances the upper ends of the structures contained within the hepatoduodenal ligament, thus hiding them from view (Fig. 2C).

In most instances, the infundibulum covered that portion of the upper end

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of the hepatoduodenal ligament which contained the right branch of the portal vein and the ramifications of the right hepatic artery. Since inflammatory processes are usually most intense at the infundibulum and neck of the gallbladder, it is not uncommon for these parts to become adherent to the above mentioned vessels. The dangers encountered here in attempting blunt separation of the denser type of adhesions are self-evident.

In 25 cadavers (12.9 per cent), the posterior portion of the gallbladder extended so far into the hepatoduodenal ligament as to cover the vessels
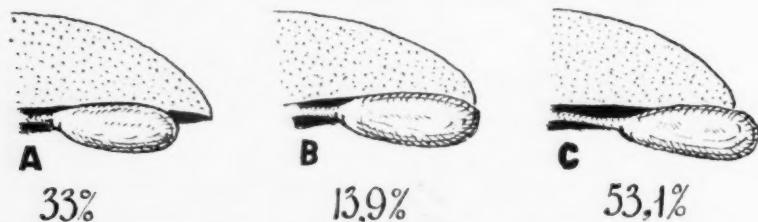

Fig. 1.—Shows various positions of the gallbladder fundus to the anterior margin of the liver. (A) Supramarginal type. (B) Marginal type. (C) Inframarginal type.

of the hilum. It also covered the upper portion of the hepatic duct. Among these 25 cadavers there were nine with an accessory hepatic duct lying behind the postero-inferior border of the infundibulum of the gallbladder. Following the anterior surface of the right branch of the portal vein (Fig. 3B), the accessory duct extended leftwards from the right extremity of the transverse fissure to join the hepatic duct proper (Fig. 3A). The chances of causing hemorrhage or injury to the biliary passages are quite evident, therefore, when operating in a field presenting the anatomic relations above described.
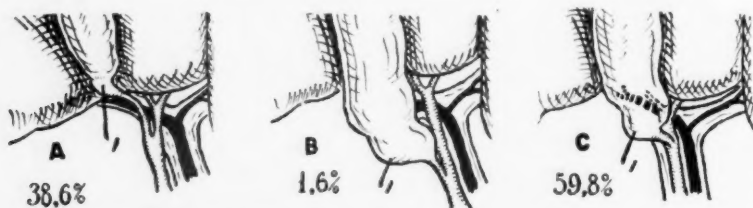

Fig. 2.—Shows the relation of the posterior part of the gallbladder to the hepatoduodenal ligament. (A) Shows the infundibulum (1) or posterior part of the gallbladder at the posterior end of the gallbladder fossa. (B) Shows the infundibulum (1) and a part of the body of the gallbladder extending downwards and parallel to the right border of the hepatoduodenal ligament. (C) Shows the infundibulum (1) and a small part of the body overlying the vascular structures in the upper end of the hepatoduodenal ligament.

In the cadaver of a man 65 years of age, the whole posterior half of the gallbladder lay upon the anterior surface of the structures of the hepatoduodenal ligament. It covered the cystic duct which arose from the junction of the middle and posterior thirds of the posterior surface of the gallbladder. It also covered almost the entire hepatic duct and a rather uncommon supplementary system of ducts 1 to 1.5 Mm. in diameter, which anastomosed with the right hepatic duct (Fig. 4). Operating upon an inflamed gallbladder of this type would be manifestly difficult and dangerous.

III. Relations of the Cystic Duct. The cystic duct, en route to its junction with the hepatic, is closely related to the cystic artery, the hepatic artery and its branches, the hepatic duct and the above mentioned accessory

Fig. 3.—Shows relationship of the accessory hepatic duct (A) to the cystic duct and right branch of the portal vein (B).
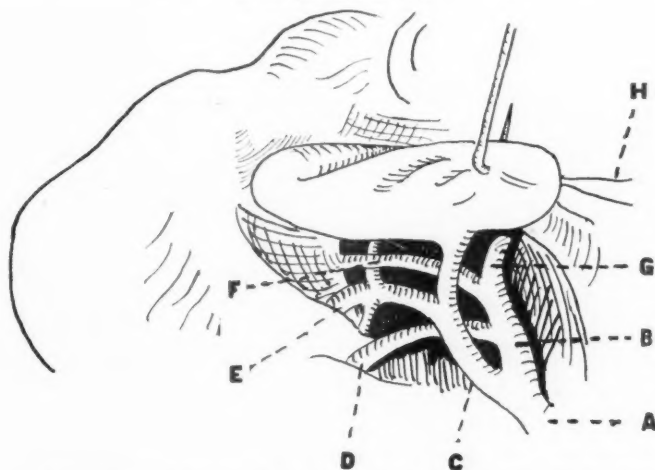

Fig. 4.—Shows the posterior half of the gallbladder overlying the cystic duct, a part of the hepatic duct and the accessory ducts. (A) Common duct. (B) Hepatic duct. (C) Cystic duct. (D) Accessory hepatic duct. (E) Another accessory duct with two tributaries joining it. (F) Right branch of hepatic duct. (G) Left branch of hepatic duct. (H) Supplementary ligament between the gallbladder, transverse colon and pylorus.

duct. In 127 cadavers (65.3 per cent), the cystic duct, usually at its commencement, lay close to the right hepatic artery or its branches, or some distance anterior to them. In three cadavers (1.5 per cent), the artery passed

to the right of and behind the duct; in one cadaver it was adjacent to its right side. In 100 cadavers (52 per cent), the right hepatic artery or its branches lay to the right of the gallbladder neck; in the remaining cadavers the artery lay behind the gallbladder without reaching to its right border. In 19 cadavers (10 per cent), the cystic duct was arched; in four of these the lower limb of the arch crossed in front of the hepatic artery.

In these cadavers the gallbladder was displaced backwards, and covered more or less considerable areas of the structures of the hepatoduodenal ligament; and the cystic duct arose below to the left of the right hepatic artery and its branches, forming anatomic variations which should be considered.
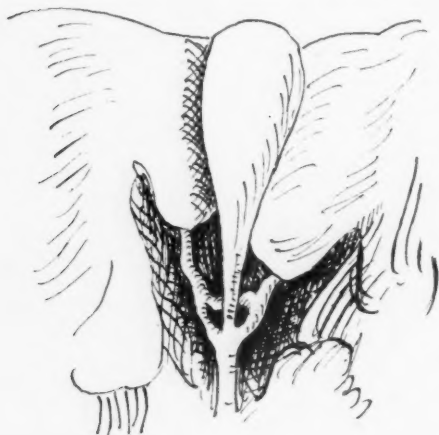

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FIG. 5.—Shows the right and left hepatic duct and the cystic duct converging to form the common duct (A).

The relations of the cystic duct and cystic artery offer less interest from the practical point of view since in cholecystectomy this artery always has to be ligated separately.

Usually the cystic artery approaches the upper portion of the duct from the left and then passes on to the gallbladder. However, in 20 cadavers (10.3 per cent), it followed the duct at a variable distance posteriorly; in 11 cadavers (5.7 per cent), it left the hepatic artery to the right of the cystic duct; in eight cadavers (4.12 per cent), it crossed behind the lower portion of the duct and approached the gallbladder from the left; once it crossed in front of the duct; and twice it left the hepatic artery and ran directly up the posterior wall of the gallbladder, which might cause confusion.

IV. SUPERNUMERARY BILE DUCTS. In ten observations (5.2 per cent), the cystic duct crossed closely in front of an accessory hepatic duct—the latter runing transversely and downward from right to left (Fig. 3A). This supplementary bile duct was noted 22 times (11.3 per cent). Three times (1.6 per cent) the cystic duct entered the point of confluence of the hepatic with the accessory hepatic duct. In one cadaver the cystic duct passed the right and left hepatic ducts and joined them at a common point, so that all three converged to form a single hepatic duct Fig. 5).

In five dissections (2.8 per cent), a large and small biliary passage emerged from the right lobe of the liver and entered the cystic duct; and in one of these cadavers the cystic duct received two such biliary passages. These accessory passages may cause postoperative biliary fistulae.

V. RELATIONS OF CYSTIC AND HEPATIC DUCT. Ruge[1] distinguishes three types of relations between the cystic and hepatic ducts: (1) The cystic joins

the hepatic duct at an acute angle (Fig. 6A).   (2) The double-barreled type
in which the cystic follows the right border of the hepatic duct for some dis-
tance before entering it (Fig. 6B).   (3) The cystic makes a spiral behind
the hepatic duct and enters it on its left anterolateral surface (Fig. 6C).   It
might be well to add a fourth type, in which the cystic follows the posterior
surface of the hepatic duct for some distance, finally entering it posteriorly
(Fig. 6D).   The first type was found 91 times (46.9 per cent); the second
type 60 times (30.9 per cent); the third type 13 times (6.7 per cent); the
fourth type 30 times (15.5 per cent).

The cystic duct may join the hepatic within the limits of the hepato-
duodenal ligament or behind the first or superior portion of the duodenum.
The former relation was observed 128 times (66 per cent), the latter 66
times (34 per cent).   According to our observations the average length of
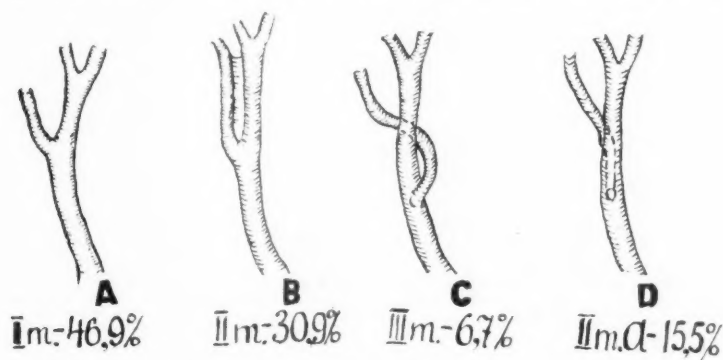

Fig. 6.—Shows the relations of cystic and hepatic ducts. (A) Cystic duct joins
hepatic at an acute angle. (B) Double-barreled type of relationship. (C) Cystic
duct makes a spiral behind the hepatic duct and enters it on its left anterolateral
surface. (D) Cystic duct follows the posterior surface of the hepatic duct, finally
entering it posteriorly.

the common bile duct within the limits of the hepatoduodenal ligament is
1.2 cm. and ranges from zero to 3.5 cm.

VI. The Common Duct. If we divide the common duct into three por-
tions: (1) that situated within the hepatoduodenal ligament; (2) that lying
behind the superior and beginning of the descending parts of the duodenum;
and (3) that entering into more or less close relations with the head of the
pancreas, we arrive at conclusions which differ from Kehr's,[2] who sup-
posed the three portions to be approximately equal in length.

Our data show the average length of the first portion to be 1.2 cm., the
second 2.1 cm. and the third 2.4 cm.   The common duct was always found
behind the duodenum, but its relation to the head of the pancreas was more
variable.   In most cases, 121 (62.4 per cent), the common duct passed
through the substance of the pancreas, was surrounded by it and then entered
the posterior internal border of the descending part of the duodenum.   A
terminal portion of the common duct located inside of the head of the pan-
creas is difficult to expose by either an extra- or a transduodenal route.
Injury to the pancreas involves considerable hemorrhage and may result

in a pancreatic fistula. Fourteen times (7.2 per cent) the common duct passed at first some distance behind the head of the pancreas and finally, before entering into the duodenum, traversed a small portion of the head of the gland. Twenty times (10.3 per cent) the whole course of the common duct lay behind the pancreas, often in a small groove, and was covered by its fascial capsule. Twenty-seven times the common bile duct passed to the right of the head of the pancreas also being covered by the fascial capsule of the gland; and finally in 12 cadavers (6.2 per cent), the common duct passed in a special bed having the head of the pancreas behind it and
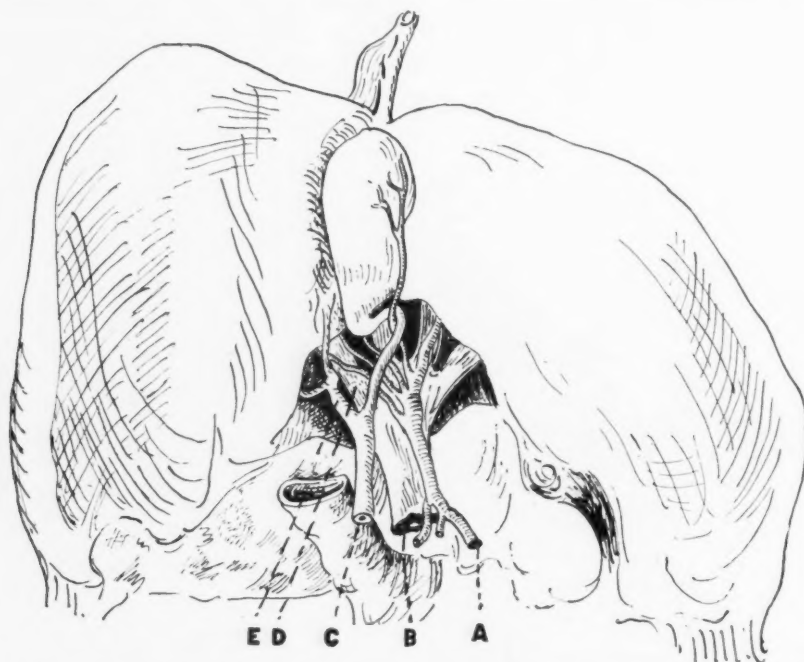

Fig. 7.—Shows the gallbladder and round ligament embedded in the same fossa—(really buried 1 cm. in the parenchyma of the liver). (A) Hepatic artery. (B) Portal vein. (C) Common bile duct. (D) Right branch of portal vein, with (E) the hepatic duct lying to its right.

the duodenum in front; the bed being represented by a groove in the anterior surface of the head of the pancreas. In 95 (48.9 per cent), cadavers the ductus choledochus entered the duodenum quite independently. In 33 cadavers it entered in the immediate vicinity of the duct of Wirsung, in 66 cadavers (34 per cent) before entering the duodenum the common duct on its way through the pancreas joined with the duct of Wirsung to form a common trunk.

The common duct entered the mucosa of the posterior surface of the duodenum at different levels of its descending portion. Thus it entered the upper half of the descending part seven times (3.6 per cent); the middle of the descending part 75 times (38.66 per cent); the lower portion of the descending part 96 times (49.5 per cent); and finally the common duct entered the upper surface of the beginning of the lower horizontal portion

of the duodenum 16 times (8.25 per cent). The initial part of the common
duct enters into close topographic relations with the arterial trunks rather
often. Thus in 21 cadavers (10.8 per cent) when the right hepatic artery
arose from the superior mesenteric, the common duct was located in front
of the right hepatic artery; the gastroduodenal artery lay in front of the
second or retroduodenal part of the common duct in eight cadavers. In five
cadavers the cystic artery arose from the gastroduodenal artery in front
of the supraduodenal portion of the common duct, went upwards in front
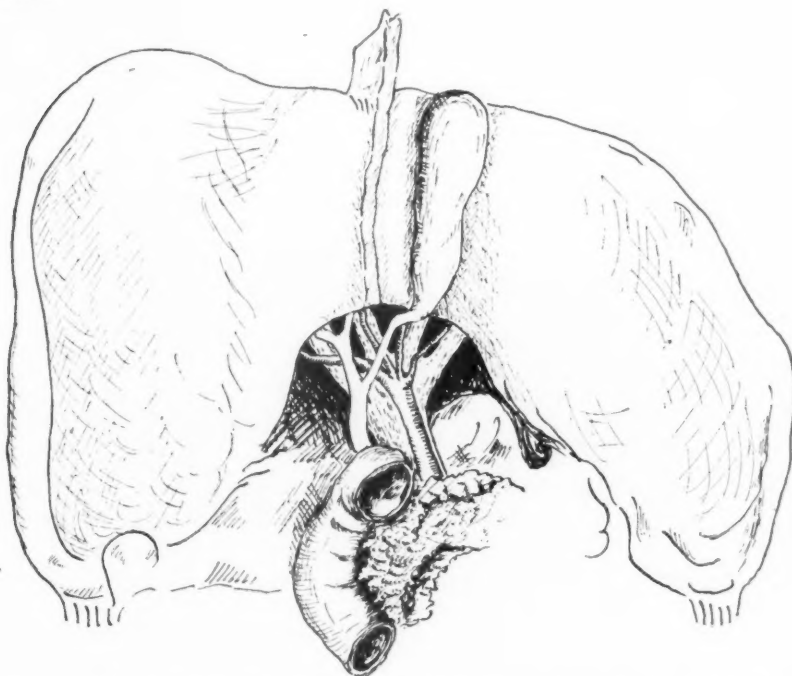of the common bile duct and then to the left of the cystic duct to the gall-
bladder.

FIG. 8.—Shows the reversed position of the gallbladder and round ligament, thus placing the
gallbladder to the left of the hepatoduodenal ligament.

VII. GALLBLADDERS LYING TO THE LEFT OF THE HEPATODUODENAL LIGA-
MENT. Finally, we found two cadavers with an anomaly in which the gall-
bladder lay to the left of the hepatoduodenal ligament. In the cadaver of a
man of 27 both longitudinal grooves were absent, and the gallbladder lay on
the lower posterior surface of the liver. The round ligament lay in the canal
of the liver parenchyma. The cystic duct entered an hepatic duct from the
left. This hepatic duct lay to the right of the portal vein, and was formed by
the union of the right and left hepatic bile passages. It lay to the right of the
branches of the portal vein and passed downwards to the right of the trunk of
the portal vein (Fig. 7). In a second cadaver, that of a woman of 30, the
right longitudinal groove of the liver was absent from its normal position, so
that the liver was subdivided only by the left longitudinal groove into right
and left lobes. The round ligament was located in the left longitudinal

groove. An oval fusiform gallbladder was suspended from the lower surface of the left edge of the left longitudinal groove by a short mesentery 0.5 cm. in length. At the posterior end of the lower surface of the left border of the left longitudinal groove, the gallbladder gradually passed into a cystic duct which ran from the left above downwards to the right, lying in front of the left branch of the portal vein and entering the hepatic duct from the left (Fig. 8).

In cases of a left-sided gallbladder the surgeon must bear in mind the course of the cystic duct, its close relation to the structures enclosed in the hepatoduodenal ligament which it crosses and also the fact that it approaches the hepatic duct from the left. If these peculiarities are taken into account, cholecystectomy may be performed in the usual way by beginning from the anterior end of the gallbladder. An attempt to begin the cholecystectomy by dissecting out the cystic duct may cause some difficulty because of its unusual and hidden situation.

CONCLUSIONS

(1) In 59.8 per cent of 194 cadavers dissected, the posterior portion of the gallbladder partly covered the right branch of the portal vein and the branches and trunk of the right hepatic artery; in 12.9 per cent it also covered the beginning of the hepatic duct.

(2) The cystic duct crossed in front of an accessory hepatic duct ten times. In five cadavers it received supplementary biliary passages from the parenchyma of the liver. Dissection of the cystic duct during cholecystectomy will injure such supplementary biliary passages and may lead to a biliary fistula.

It is not likely that a surgeon will recognize these small accessory ducts during the course of a cholecystectomy. However, should he notice a large accessory duct, the location of which makes its ligation difficult, then it may be wise to remove only the gallbladder, and leave the cystic duct.

(3) In 69.6 per cent of this series the common duct passed for some distance through, or was partly surrounded by, the parenchyma of the head of the pancreas before entering the duodenum; an anatomic relationship which might cause hemorrhage from the pancreas in attempting to expose the intrapancreatic portion of the duct.

(4) Two cadavers with a left-sided gallbladder and absence of the quadrate lobe of the liver are described.

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TUBERCULOSIS OF THE BREAST

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SIR ASTLEY COOPER described the manifestations of tuberculous disease of the breast as a "scrofulous swelling of the bosom" (1829). This term was descriptive of the advanced type which was brought to the attention of the earlier clinicians and which was often associated with obvious tuberculosis in other organs. Virchow believed the breast was immune to tuberculosis. Lanceraux, in 1860, was the first to establish the diagnosis by microscopic examination. Cuneo, in 1868, isolated the organism from the pus and successfully inoculated an animal with it. The presentation of Dubar's thesis in 1881 furnished a stimulus to the study of this condition as shown by the number of cases reported in the two decades following. Scott,[19] in 1904, reported the largest series of cases (25). In 1930, Morgen[16] collected 439 cases in a comprehensive review of the subject, including six cases of his own.

Incidence.—The incidence of tuberculosis of the breast may be appreciated by a comparison of more than 450 reported cases with the large number of instances of tuberculosis of other organs and also by the percentage of breast lesions which it constitutes. The number of cases has been expressed in per cent of all breast cases operated upon, 1.04 per cent (Gatewood[13]); all benign lesions, 5 per cent (Bloodgood[3]); all breast carcinoma, 2 per cent (Scott[19]); and all mammary conditions requiring hospitalization, 0.51 per cent (Durante and McCarthy[9]). Elkin,[10] in 1923, stated that the 200 cases reported up to that time constituted about 1 per cent of all breast diseases. The series here reported includes four cases constituting 1.3 per cent of all the malignant breast lesions and .83 per cent of all cases of mammary disease admitted to the Wisconsin General Hospital from 1924 to 1935.

Classification and Etiology.—The cases are classified as primary or secondary. Where there is no demonstrable lesion other than the one in the breast, the cases are attributed to infection entering through the ducts, skin abrasions, or blood stream. The passage of the infecting organism through abrasions and ducts has been assumed to have occurred in those cases in which history of contact with articles or material harboring tubercle bacilli has preceded the discovery of mammary tuberculosis. Examples of this kind include Ely's[11] case in which the disease was discovered in a breast which had been covered previously by a piece of linen thought to be contaminated with sputum from a patient who had tuberculosis. Fricke[12] reported the case of a woman whose breast contained a tumor which was massaged by her husband. He had pulmonary tuberculosis. Both tuberculosis and carcinoma were found in the breast at operation.

Hematogenous origin as a source of primary cases has been discredited. It seems unlikely that the tubercle bacillus would enter the blood stream without affecting the tissue through which it passed. Furthermore, it would mean that such an organism, once having gained entrance to the blood stream, would attack the breast in preference to all the other organs, many of which seem to have much less resistance to invasion by this organism. Nagaskima,[17] in 1925, reported 34 cases of disseminated tuberculosis in which no tuberculosis of the breasts was found at autopsy. This work does not substantiate the hematogenous origin of the secondary cases.

The secondary cases are ascribed to invasion by way of lymphatics or contiguous structures. The question of lymphatic origin has resolved itself into a discussion of the presence of involved lymph nodes and whether they were found before or after the disease was discovered in the breast. Barker,[1] in 1926, stated that no more than 5 per cent of the cases were due to extension from axillary or cervical nodes. He noted that half the compiled cases did not have palpable axillary or cervical nodes. He added that many instances of axillary involvement had been preceded by the discovery of the mass in the breast. In Raw's[18] case the successive enlargement of the cervical and axillary lymph nodes on the right and the right breast indicated invasion by a retrograde lymphatic route. Direct extension from contiguous structures has been reported, the primary foci being in the ribs or sternum.

Only the bovine type of organism has been identified in the cases reviewed by Morgen.[16] It would seem that the evidence in this respect is not adequate, as a sufficient number of cases have not been investigated bacteriologically. Barker and Raw have expressed their belief in the predominance of the bovine type.

Heredity does not seem to play any special part in this disease. Trauma, always considered a factor, probably plays a rôle in so far as damaged tissue constitutes an area of lessened resistance. As has been said of carcinoma of the breast, it is quite difficult to evaluate trauma when considering its effect on an organ so obviously exposed to it. The occurrence of bilateral tuberculosis of the breast two weeks after the use of hypodermoclysis needles in those areas is especially significant (Case 3). Cahill's[6] case was discovered approximately two months after the occurrence of a blow on the breast.

The disease attacks a predominant number of females. Only 20 cases in males have been reported by Morgen. One additional case in a male has been reported by Battista[2] in 1931. Many cases have developed during lactation. Cheever's[7] case and one instance in this series are examples. The age group between 20 and 40 includes over half of the cases but this is of no assistance in distinguishing the process from carcinoma.

Many authors believe that mammary tuberculosis is always secondary to a focus elsewhere and that retrograde lymphatic extension is responsible for its occurrence. It is difficult to rule out such a focus. The lack of recurrences following local excision is hard to explain.

The area of diminished resistance is probably the most important etiologic factor as the development of the breast lesion is not usually accompanied by the onset or exacerbation of symptoms of the initial tuberculous focus. Such a view provides for the consideration, as etiologic influences, of those changes which occur in the breast following trauma and during the puerperium and lactation.

Association with Carcinoma.—The doctrine of Rokitansky which holds that a tissue is not invaded by carcinoma and tuberculosis simultaneously has long since been disproved. Broders[5] reported a series of 22 cases in which tuberculosis and carcinoma were demonstrated in the same tissue. In seven of the cases the two lesions were seen in the same microscopic field. Numerous cases of involvement of the breast in which both lesions were present have been reported and in most instances there is only presumptive proof in regard to the priority of either lesion. Warthin[21] reported three cases of tuberculosis of the breast, two of which were associated with carcinoma. The microscopic sections of tissue from Maker's[15] patient showed tubercle bacilli and carcinoma cells.

Symptoms and Course.—The lesion is usually unilateral. Simultaneous or successive involvement of both breasts is quite rare. The right breast has been slightly more often invaded but this ratio is without significance. In most instances the discovery of a lump in the breast has been the earliest symptom. Pain has been noted by relatively few patients. The subsequent symptoms and findings depend, to a large extent, on the type and course of the process.

The nodular type tends to remain localized. One or many lumps may be found on physical examination. The confluent type is seen in those cases where coalescence of involved areas has occurred. Such a breast is usually enlarged. On section it shows many caseous areas or abscesses which intercommunicate. This type pursues a more rapid course than does the nodular variety, especially in the lactating breast. Both varieties usually break down and form sinuses if their progress is not interrupted by surgery.

The intraglandular cold abscess is a variation of the confluent type and represents a more effectively walled off process. The sclerosing type is still more rare. It is usually found in older patients and, as the term implies, tends to render the organ small and hard. It quite frequently causes deformity of the breast and is termed by some authors the pseudoneoplastic form. Morgen points out that this type has been compared to fibroid phthisis because of the age group in which the two lesions are most frequently found. Sinuses rarely occur in this type.

The overlying skin may resemble the "orange peel" change seen in carcinoma. It exhibits, first, the edema and discoloration of lymph and venous stasis. Later, as sinus formation is imminent, redness and heat are added to the picture which is then more characteristic of inflammation.

Early invasion of the axillary nodes is quite characteristic of the disease and was found in 236 of the 439 cases reviewed by Morgen. Some of

the remaining cases in the series may have had glandular extension but, as frequently occurs in carcinoma of the breast, it may have been impossible to demonstrate clinically.

Diagnosis.—Morgen says: "The clinical findings are not always sufficient to aid the physician to make a correct diagnosis. A lump in the breast of long duration not associated with pain or retraction of the nipple but associated with glandular enlargement is very suggestive. If to this is added the presence of a fistula discharging a gritty caseous material one can fairly safely make the diagnosis of breast tuberculosis."

The diagnosis is usually easily made from the microscopic picture. The presence of caseation, epithelioid hyperplasia, and the typical Langhans' giant cell with peripherally placed nuclei are generally sufficient to identify the process. The organisms are recovered from the lesions with difficulty.
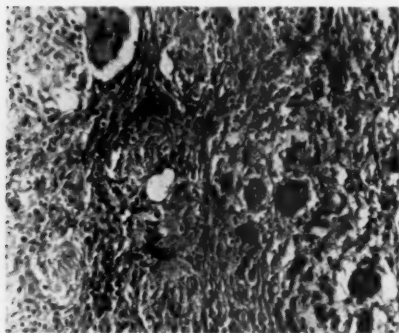

FIG. 1.—Photomicrograph showing breast tissue in which there is a marked inflammatory reaction. The most characteristic feature is the endothelial hyperplasia and tubercle formation. Some of these tubercles contain Langhans' giant cells. Elsewhere, there is infiltration by lymphocytes and plasma cells. There is caseation with abscess formation, the wall of the abscess cavity being lined by large epithelioid cells.
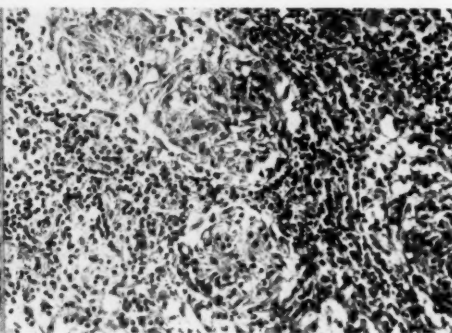
FIG. 2.—Photomicrograph showing no breast acini, but a chronic inflammatory reaction, which is characterized by lymphocytic infiltration, epithelioid tubercles and giant cells. Some of the giant cells are of Langhans' type, but the majority resemble foreign body giant cells. No frank caseation is apparent.

The correct diagnosis was made in one of the four cases in this series (Case 2). The other cases were diagnosed chronic mastitis, carcinoma, and adenofibroma.

Treatment.—The treatment has been surgical in most cases but the extent of interference has varied. Scudder[20] reviewed the treatment used up to the time he wrote his article (1898) and found it included the following: (1) curettage of the sinuses; (2) cauterization of the sinuses; (3) excision of the tumor; (4) excision of the tumor and the breast; (5) excision of the axillary nodes; and finally (6) the excision of both the axillary nodes and the breast. In the 63 cases analyzed by Barker only 14 of them had surgery which included the removal of axillary nodes.

The treatment at the present time consists of removing the local process. If multiple sinuses are present and there is invasion of the axillary nodes, a radical mastectomy may be indicated. Hartwell's[14] case was treated by local excision, and the enlarged axillary node subsided spontaneously.

The general tendency to investigate surgically any lump in the breast will cause tuberculosis to be discovered in its early stages. This will permit more conservative operations and increase the number of cases in which local excision will suffice.

Prognosis.—One of Gatewood's[13] cases which was operated upon in 1909 returned in 1912 with a small abscess in the same breast from which the tubercle bacillus was isolated. A diagnosis of tuberclosis had been made in 1909 from microscopic section. In Morgen's review of the subject there were 11 cases in which a history of previous breast abscess was elicited. There seemed to be no indication that the tuberculous processes subsequently discovered represented recurrences.

Deaver,[8] in 1914, reviewed the results listed in the cases up to that time, and tabulated them as follows:

Results not listed... 41 cases
Uneventful recovery .... 13 cases
Not operated upon .... 1 case
Healed by primary intention .... 1 case
Discharged in good condition .... 3 cases
Fistula remained .... 2 cases*

   * One followed "a simple mastectomy and cleaning of the axilla," and the other followed simple excision.

The remaining 13 cases were alive and well "several months" to 13 years later. Braendle's[4] follow up notes on 15 cases showed that two died several years later from tuberculosis but without evidence of local recurrence. Of the remaining 13 none had shown local recurrence, or evidence of the disease elsewhere four, eight, and 11 years later. Of the 13 living patients, ten were between 40 and 50 years of age at the time of the report (1906).

CASE REPORTS

Case 1.—Hospital No. 57987. Surgical Pathology No. 12096. J. Z., a white female age 41, entered the Wisconsin General Hospital January 5, 1932. She had first noticed a painful and tender lump in the left breast in the spring of 1931 while nursing her tenth child. The pain, which was fairly constant, became more marked during menstrual periods, and necessitated weaning the child. In November, 1931, the breast opened spontaneously and pus drained through the opening overlying the mass in the outer quadrant of the left breast for about a month. The drainage subsided and the breast healed about three weeks before the patient entered the hospital. There was no history of trauma, tuberculosis, or of any previous breast involvement. There were no pulmonary symptoms.

Physical examination demonstrated the presence of adenopathy of the anterior cervical nodes and an irregular discrete elastic mass in the outer quadrant of the left breast. The overlying skin was discolored and fixed. Moderate retraction of the nipple was seen. No axillary adenopathy was present. The liver edge was palpable and slight edema of the extremities was noted. Roentgenography of the chest revealed a slight peribronchitis. The uranalysis, complete blood count, blood chemistry and serology determinations showed normal findings. A diagnosis of chronic mastitis was made. On January 8, 1932, local excision of the mass in the outer quadrant of the breast was performed. The central portion of the mass showed an abscess cavity and microscopically both acute and chronic inflammation was seen, the latter process predominating. Tubercles and giant cells were

plentiful in these sections. A slight amount of drainage was present when the patient left the hospital January 23, 1932.

Case 2.—Hospital No. 55572. Surgical Pathology Nos. 14263, 14460. M. H., a white female, age 41, had previously been a patient in the Wisconsin General Hospital during July and August, 1931, at which time a diagnosis of bilateral infected hydronephrosis was made. Colon bacilli were demonstrated by culture in the urine obtained from each ureter. Appropriate treatment was given and the infection subsided. The breasts were found to be normal at that time, but the nipples were tender. The lungs were normal as determined by physical examination.

On readmission, December 5, 1932, the patient complained of a tumor in her left breast, first noticed in June, 1932. The mass was about eight centimeters in diameter. Itching of the left breast had been experienced occasionally. On December 2, 1932, the overlying skin, which had become hot and red, broke through, releasing about a teacupful of yellow pus. The past history revealed attacks of redness and heat in the left breast which had been treated successfully with moist heat. There was no history of trauma to the breast. The patient nursed two of her children, the periods of lactation being uneventful. No difficulty was encountered in the right breast. History of "winter colds" and a mildly productive cough was elicited. No tuberculosis in collaterals or forebears was reported. In March, 1932, a mass in the right side of the neck was incised and had continued to drain. The marital history revealed five pregnancies and three miscarriages.

Physical examination revealed a poorly nourished patient. The jaws were edentulous, the tonsils moderately enlarged. There was a soft tumor mass and an adjacent draining sinus in the right side of the neck. No axillary adenopathy was present. The left breast contained many rope like masses. An ulcer measuring 2 by 3 cm. was present in the lower outer quadrant.

Complete blood count and blood chemistry were within normal limits. Uranalysis and blood Wassermann were negative. No tubercle bacilli were found in the sputum. Smears and cultures of the wound in the left breast were negative for tubercle bacilli. Roentgenographic examination of the chest showed an irregular fibrous increase of the right hilum and a single calcified deposit in the left apex. A diagnosis of mammary tuberculosis was made.

On December 12, 1932, a simple mastectomy was performed. One sinus was found to extend down to the pectoralis fascia. On January 14, 1933, the sinus tract in the right side of the neck was excised. The tissue removed at each operation showed caseation and giant cell formation and was diagnosed tuberculosis. Healing in both areas was satisfactory. The patient was discharged January 21, 1933. On readmission, April 5, 1933, for care of congenital cataracts, the neck and breast wounds were well healed. The sputum was negative. Roentgenogram of the chest showed no significant change. No signs of tuberculous activity were found clinically.

Case 3.—Hospital No. 56749. Surgical Pathology Nos. 17674, 17751. I. S., a white female, age 36, was readmitted to the Wisconsin General Hospital April 28, 1934. On February 4, 1934, she had had a cholecystostomy elsewhere and following the operation hypodermoclysis had been used, the needles having been inserted at the lateral borders of the breasts. These areas remained sore. Two weeks later (February 18, 1934), she noticed a lump in the outer quadrant of the right breast. Some sharp pain had been noticed in this area. The mass had not increased in size since its discovery. Inventory by systems was essentially negative. No history of tuberculosis in forebears or collaterals. The patient had five children and one miscarriage. In 1918 both breasts had multiple abscesses which had healed and caused no further trouble. In 1929, an eczematoid lesion was present about both nipples but it subsided with simple treatment in two weeks. There had been no discharge from the nipples.

The submaxillary lymph nodes were palpable. A mass, 3.5 cm. in diameter was found in the outer quadrant of the right breast. It was discrete and attached to the

overlying skin, a portion of which was discolored and edematous over an area about
1 cm. in diameter. No enlargement of the axillary nodes on either side was demonstrable.
A similar mass was found in the left breast but with no change in the overlying skin.

The uranalysis, blood count, blood chemistry, and serology did not demonstrate any
abnormalities. Roentgenographic examination of the chest revealed a caseocalcareous
lymphadenitis of the right hilum. A diagnosis of carcinoma of the breast was made. At
operation, May 5, 1934, a local excision of the mass was performed. Green pus was en-
countered and the area was drained. Ten days later the mass in the left breast was
removed and green pus was released.

Microscopically the tissue from each breast showed epithelioid hyperplasia, caseation
and giant cell formation. Smears and cultures from the wound in the right breast six
days after operation showed Staphylococci. The tissue and a swab of the pus from the
left breast were cultured but the tubercle bacillus was not recovered. Intradermal tuber-
culin test was positive in 48 hours. Both breast wounds healed well and the patient was
discharged June 8, 1934.

Case 4.—Hospital No. 58302. Surgical Pathology No. 18693. E. I., a white female,
age 34, was first admitted to the Wisconsin General Hospital in January, 1932, at which
time a ventral hernia which had occurred following a laparotomy in 1929 was repaired.
There were no respiratory symptoms, the lungs were normal, and no masses or tender-
ness were noted in either breast. There was no history of tuberculosis in collaterals or
forebears. On readmission, August 21, 1934, the patient complained of a tumor in her
left breast which was first noticed in March, 1934, and had gradually increased in size.
No axillary adenopathy was demonstrable. Intermittent pain had been experienced but
it was not definitely associated with menstrual periods. The patient could remember no
trauma to the breast and no discharge from the nipple. Recurrence of the ventral hernia
was noted. The patient had been married 13 years, had been pregnant three times, and
had had one miscarriage.

Uranalysis and blood Wassermann were negative. The complete blood count and
blood chemistry were within normal limits. A diagnosis of adenofibroma was made. On
August 24, 1934, local excision of the mass was performed. It proved to be an abscess
filled with green pus. The wound was drained. Healing was satisfactory. Microscopic
section showed numerous hyperplastic tubercles with giant cells. The diagnosis was
tuberculosis. Smear, culture, and guinea pig inoculation failed to demonstrate tubercle
bacilli. The breast wound healed satisfactorily and the patient was discharged November
10, 1934.

CONCLUSIONS

(1) Four cases of tuberculosis of the breast are presented. All were in
females, one was bilateral, and two were primary. The diagnosis in each
case was proven by microscopic section. One case was diagnosed correctly
before operation.

(2) Mammary tuberculosis is not as rare as it is ordinarily thought to be.
It occurs in many individuals who show no other tuberculous lesion. It is not
often diagnosed before operation unless sinuses are present or unless the
patient is known to have tuberculosis of some other organ.

(3) Since the development of the breast lesion is not usually accompanied
by the onset or exacerbation of symptoms of a tuberculous process elsewhere
in the body, the area of lessened resistance is the most important etiologic
factor.

(4) Recurrences after operation are rare.

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MEDIASTINAL TUMOR CAUSED BY HODGKIN'S DISEASE*

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Lymphadenoma (Hodgkin's disease) apparently is an infectious granuloma with a characteristic histologic picture and a typical clinical course. The clinical aspect is usually that of a slow, painless, progressive enlargement of the lymphatic nodes of the body, beginning with those of the cervical chain. Later, other organs, especially the liver and spleen, are involved. Generally the disease is considered as incurable, although improvement for many years may follow treatment.

In the typical case the cervical nodes are the ones first affected. In the statistics compiled by Baldridge and Arve (1930) the mediastinal nodes were reported as primarily enlarged six times in a total of 136 cases. Wessler and Green (1920) and others distinguish a mediastinal tumor caused by Hodgkin's disease. Ewing concludes that mediastinal Hodgkin's disease is a thymic tumor and different from the ordinary Hodgkin's disease.

Ziegler, in his monograph, describes the mediastinal type of Hodgkin's disease in detail and states that it may be impossible to determine whether the processes arise in the lymph nodes or in the thymus, since at the stage at which death occurs there is no evidence of thymic origin. He believes that it may be assumed that the granulomatous process has its origin in the peritracheal lymph nodes and that larger single granulomatous masses are secondarily formed in the anterior mediastinum, the loose tissue of which favors the formation of large single masses. Apparently he questions the occurrence of purely single Hodgkin's tumors in the anterior mediastinum and suggests that the primary seat may be in the lymphatic tissue of a persistent thymus.

Hodgkin's disease is considered as being sensitive to radiation and thymic new growths as being radioresistant, and hence it would seem that the reaction of mediastinal tumors to a test dose of radiation would be of value in their differential diagnosis. Haagenson believes this to be true. It is not true in the case herein reported because this patient was thoroughly treated by radiation without improvement and yet the histologic picture is precisely that of Hodgkin's disease. We must assume, therefore, that it represented an unusual case of radioresistant Hodgkin's disease or was of thymic origin indistinguishable from Hodgkin's. There is no evidence of thymic tissue in the microscopic sections.

Case Report.—No. 713. 1936. Female, age 17, was admitted to the Misericordia Hospital August 17, 1935, complaining chiefly of dyspnea on exertion. Her history

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dated back to February, 1933, at which time she was given a tuberculin test at school which showed a slight reaction (plus one). A roentgenogram of the chest showed a shadow on the left side that was considered as being either a persistent thymus, a mass of tuberculous lymph nodes, or possibly a sarcoma. Six months prior to this time, however, she complained of a dry cough which lasted the entire summer of 1932. Shortly after the detection of the mediastinal shadow the patient was put to bed and remained there for a period of one year. During this period no abnormal temperature, cough, pressure symptoms or loss of weight was noted, although the patient developed a general physical weakness which has continued.

In September, 1933, she was given a series of roentgen therapy treatments, but, if anything, there was enlargement of the shadow rather than a diminution. In March, 1934, she was again examined and at that time the diagnosis was made of a benign tumor of the mediastinum or an enlarged thymus gland. The patient was allowed out of bed to lead a normal life but without strenuous exercise. In September, 1934, she was admitted to the Hospital of the University of Pennsylvania. Roentgenologic examination by Doctor Pendergrass showed a shadow inseparable from that of the heart, and he believed the case was one of benign tumor of the anterior mediastinum, suggesting the possibilities of a cyst springing from the pericardium, a thymoma or a lipoma. He noted that the mass was considerably larger than was noted in the roentgenograms taken a year previously. She was seen by Doctor Wolferth, who advised a conservative policy unless there was evidence of bronchial compression. She was bronchoscoped by Doctor Tucker, who found that there was an oval appearance of the lumen of the left main bronchus but no indication of localized compression or infiltration of the left bronchial stem. He also believed that unless the condition caused symptoms from pressure or inflammatory exudates, it might be better to keep the patient under observation. This was done, but in the summer of 1935 it was felt that the shadow was getting larger, and accordingly she was referred for operation.

At the time of her admission, as has been noted, there were no symptoms except weakness and dyspnea on exertion. There was an area of dulness corresponding to the mass seen in the roentgenograms, with evidence of pulsation. We agreed with the earlier report of Doctor Wolferth that this was a transmitted pulsation and not that due to aneurysm.

Roentgenologic Examination.—By Doctor Bertin. Chest examination in the P. A. view shows an enormous enlargement of the cardiac silhouette and depicts an abnormal projection smoother in contour from the left border of the heart shadow. The right border of the cardiac shadow is displaced to the right. The lateral view shows this entire huge shadow overlying the heart shadow anteriorly. The posterior border of the shadow is slightly more prominent than normal and impinges only very slightly into the mediastinal space. It is therefore likely that this mass does not originate in the posterior mediastinum. Its nature and exact extent cannot be demonstrated from the film alone. There is a sharp angulation in the middle of the right diaphragm which is characteristic of pleural adhesions. There are numerous small calcified bronchial lymph nodes on both sides with no evidence of active disease in either lung. The left base is slightly more dense than the remaining portion of the lung area, possibly due to compression resulting from the enlargement in the anterior chest.

Fluoroscopically we were able, however, by rotation in various positions, to determine the cardiac silhouette apart from this general mass to the left of the cardiac border. During forced inspiration the apex of the heart could be clearly visualized and the cardiac shadow showed no evidence of enlargement. The mass showed general wave like pulsations corresponding with the heart beat but decidedly less marked, giving the impression of a cyst like mass, situated immediately in front and to the left of the heart shadow.

The impression finally arrived at was that she had either a dermoid cyst or a benign tumor such as a fibroma or lipoma. It is interesting to note that a cousin died some

years previously from a condition suggestive of a large sarcoma or tumor in the mediastinum. No operation was performed.

Except for being thin and somewhat weak the patient was in good general condition. Hemoglobin 65 per cent. R.B.C. 3,060,000. There was no leukocytosis. A Wassermann test was not made. Operation was performed August 20, 1935, under gas-ether anesthesia with provision for positive pressure in the mask. Arrangements were made for endotracheal anesthesia if such was deemed necessary. As a matter of fact there was no trouble with the anesthetic.

Operation.—An incision was made, similar to that described by Graham, and extended transversely over the level of the fourth rib three inches on either side of the sternum. As the exact relation of the tumor to the heart, its adhesion and its location were somewhat uncertain, it was thought advisable to begin on the right side so as to approach it from near the median line, and work across. As in Graham's technic, the sternum was to be divided transversely. Accordingly the third and fourth ribs were exposed and a small portion of the cartilages removed on either side. With finger exploration across the posterior aspect of the sternum it was found that the tumor was anterior to the heart in the anterior mediastinum, that it was solid and not cystic, and was encapsulated. The fourth costal cartilage on the left side was then removed for a short distance and the sternum divided with a Gigli saw. Sometime during this procedure the right pleura was nicked but as the lung was easily inflated and the pleura readily closed with catgut sutures, it was thought that no harm had resulted, although later a moderate degree of pneumathorax was noted. The divided sternum was then retracted and the tumor mass, measuring 6 by 4 by 2 inches in size, was gradually dissected from the surrounding structures. It was impossible to do this without a wide opening of the left pleura. A small pedicle, perhaps one-eighth of an inch in diameter, tapering upwards toward the neck, was divided. It seemed to carry a blood supply. The tumor mass was then drawn from the wound and the pleural cavity on the left side sutured as carefully as possible, although it was realized that this was imperfectly accomplished owing to its thinness. The sternum was drilled and a doubling suture of number two chromic catgut introduced to draw it together in a mattress fashion. Owing to the fact that a good deal of oozing was present in the mediastinum and fearful that this might seep into the pleural cavity, it was thought advisable to introduce a cigarette drain for a few days. It was thought that the pleura would become adherent to the tract and obliterate it. In this we were in error. The muscles, fascia and skin were brought together and the patient given 500 cc. of citrated blood intravenously. She left the table in good condition.

As things turned out it would have been satisfactory to have approached this tumor entirely from the left side, but the roentgenograms were somewhat misleading in making us believe that it was under the sternum, extending to the left, when actually it barely touched the sternum on the left side.

Following the operation the patient had a stormy first 48 hours, probably due to the considerable pneumathorax remaining on the left side and the moderate pneumathorax on the right side, thus causing a limitation of vital capacity. She was kept in an oxygen tent for four days and was able to breathe easily without dyspnea after removal from the tent. The cigarette drain was removed. However, dyspnea always was pronounced and the patient seemed to have difficulty in moving the thoracic cage during and after respiration. This produced, I think, a sawing effect on the catgut because in about ten days' time the lower part of the sternum sank somewhat and this seriously interfered with the motions of the lower part of the chest. This was disastrous in another way because it kept the wound opened at the site of drainage and we soon saw that this communicated with the left pleural cavity, keeping up the pneumathorax in spite of every effort made to plug this hole and remove the air in the left chest by aspiration. Shortly afterwards she developed a pleural effusion on the right side which was aspirated several times and

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still later she developed a purulent effusion in the left cavity although at first no organisms were found to culture but later a Staphylococcus albus was discovered.

On September 19, 1935, under local anesthesia, an interrib drainage was introduced, attached to a continuous aspirator, following which there was a considerable increase in the expansion of the left lung. Early in October the right side appeared to show but little fluid and only a small degree of pneumathorax. Collapse of the left lung, however, was total. At this time I anticipated that the patient might make a difficult but an ultimate recovery. It should be mentioned that several transfusions were given during this time.
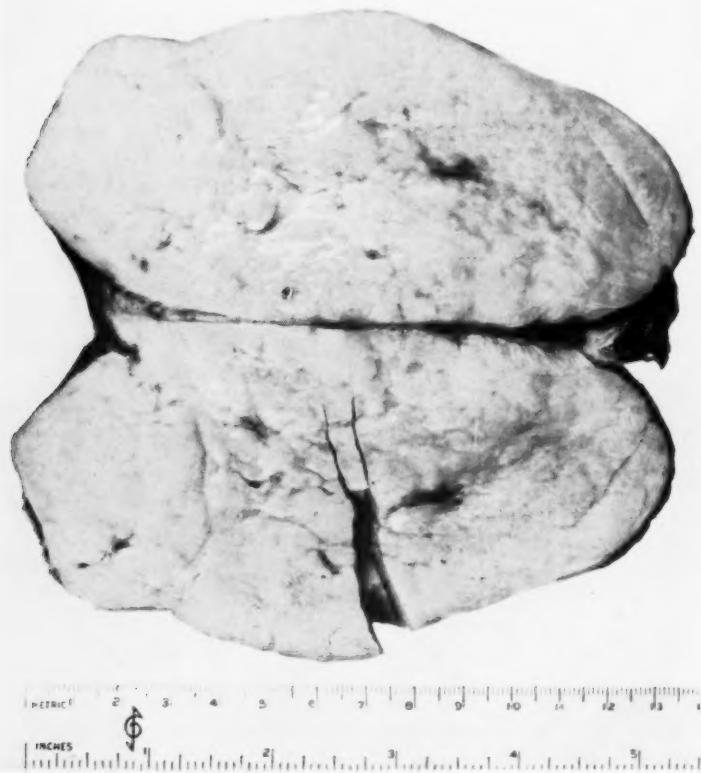

Fig. 1.—Appearance of tumor on bisection.

However, on October 17, 1935, she developed a cold, an acute bronchitis and apparently a bronchial pneumonia, which so violently interfered with the respiratory function that nothing availed and she died October 19, 1935.

Pathologic Examination.—By Doctor Camero. The specimen consists of a well circumscribed, well encapsulated, ovoid, tumor mass measuring 15 by 12 by 10 cm. The surface is smooth. The cut surface is uniformly white, firm around the periphery and softer in the central portion. The mass is not very vascular (Fig. 1).

Microscopic Examination of several sections made from the tumor mass shows the tissue to be undoubtedly lymphoid in origin. Lymph node architecture is almost completely destroyed though there persist small follicles and an hyperplastic reticulum. The chief histologic features are: (1) Irregular abundant fibrosis, some of which has undergone a sclerosing process. (2) Marked variation in the type of cells. The following types of cells are predominant, lymphocytes, eosinophils, neutrophils, fibroblasts, mono-

cytes, other mononuclear cells and typical Dorothy Reed giant cells. (3) Necrosis. Scattered areas show necrosis (Figs. 2 and 3). The histologic picture here seen and above described is typically that of Hodgkin's disease. The sections were shown to Dr. Herbert Fox, who confirmed the diagnosis.

An autopsy showed nothing that was not known prior to death, the principal features of which were an atelectasis of the left lung, a bronchial pneumonia with partial atelectasis of the right lung and the remnants of a left empyema. There was an hyperplasia of the lymph nodes in the mediastinum but no evidence of Hodgkin's disease in them. There was no evidence of the nodules of Hodgkin's disease in the spleen, liver, pancreas or kidneys. The heart and pericardium were normal. The patient apparently died from the bronchial pneumonia following the greatly lessened air capacity of the two lungs.
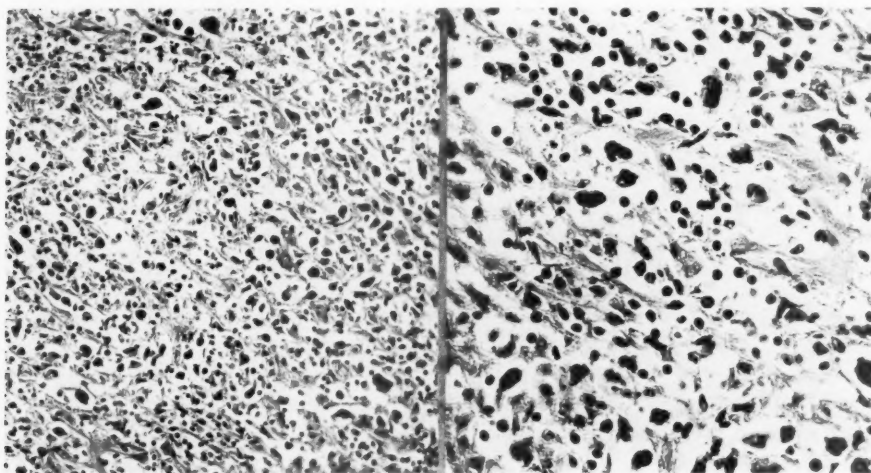
Fig. 2.—Photomicrograph of section of tumor of the anterior mediastinum (×122).

Fig. 3.—Photomicrograph of section of tumor of the anterior mediastinum (×393).

DISCUSSION.—DR. CARL EGGERS (New York).—There are several angles from which this case may be discussed: (1) The presence of an isolated Hodgkin's tumor in the mediastinum. (2) The treatment of Hodgkin's disease by surgery in general. (3) Removal of a mediastinal tumor, and the technic employed.

Most clinicians and pathologists, however, agree that a glandular tumor, usually multiple in character and showing on section typical structure and presence of certain cells including Dorothy Reed cells, lymphocytes, plasma cells, endothelial cells, eosinophilic leukocytes and multinucleated giant cells, may be regarded as a malignant granuloma or Hodgkin's disease.

The question which interests us as surgeons is whether Hodgkin's disease is at first a local disease, like a malignant tumor, and whether recognition and removal at this time may cure the disease, or whether it should always be considered a general affection of the lymphatic system.

There is ample evidence that at times removal of a single mass of involved Hodgkin's lymph nodes is followed by a long period of freedom from the disease or even an apparent cure, similar to carcinoma in which the primary tumor has been removed and apparent cure results until metastases make their appearance.

In the majority of cases the exciting agent is supposed to enter through the mucous membrane or through lesions of the skin, and the cervical and supraclavicular nodes are usually primarily affected. At times the disease

first makes its appearance in the abdominal, mediastinal, inguinal or other nodes.

Where the source of entry was in the case described by Doctor Muller is impossible to state. The tumor was found during a routine examination, and it is interesting to note that it did not respond to roentgen therapy. During the Annual Meeting of the American Association for Thoracic Surgery in 1928 Dr. William Lerche[1] reported an interesting case in which had developed successively Hodgkin's tumors in the left and right supraclavicular fossae and finally in the mediastinum. He performed incomplete operations followed by roentgen therapy. There was a clinical cure and the patient was in excellent health at the time of publication, 18 years after the onset of the disease and seven years after the last operation. With his characteristic attention to detail, Doctor Lerche has worked out the probable course of extension of the disease from the neck to the mediastinum and his article can be highly recommended to those interested in this subject.

The question may be asked whether Doctor Muller would have operated had he known in advance that the mass was an isolated Hodgkin's tumor. Though the surgical treatment of Hodgkin's disease is not popular at the present time, I believe that unless there is generalized disease present an attempt at removal of the primarily involved nodes, followed by roentgen therapy, is justified.

On the other hand, most of the more recent contributions stress the value of roentgen therapy alone. Clinically one may recognize favorable features of the disease, and less favorable ones. Localization in one area is held by most observers to be a favorable sign, and it is this variety which lends itself to surgery. In that sense Doctor Muller's case might have been considered surgical even had the diagnosis been known in advance, especially in view of the fact that it did not respond to roentgen therapy.

<div align="center">REFERENCE</div>

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JEJUNAL INTUSSUSCEPTION

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The classification of intussusception is, at times, confusing. That suggested by Perrin and Lindsay,[7] namely, ileocecal, ileocolic and enteric types, is quite satisfactory. The terms are self-explanatory with the possible exception of ileocolic, which begins as an enteric type, involving the terminal ileum primarily, and then passes through the more or less fixed ileocecal valve, and as it progresses, drags the cecum with it. While the term enteric covers all intussusceptions involving the small intestines, these might better be divided into ileal, jejuno-ileal and jejunal.

The cases involving the small intestine alone form a small but interesting group, and because of the distinctive features presented, it is felt that they should be considered separately.

The comparative frequency of intussusception involving the small intestine alone and that involving the small and large intestine, or the large intestine alone, has been discussed by several writers. The present problem, however, concerns itself with the incidence and comparative frequency of the true jejunal type. All reports and statistics in the literature were reviewed, and no consideration of this condition, as an entity, was found.

In Leichtenstern's series[1] of 593 cases there were recorded 178 enteric cases with only three jejunal types. Hutchinson[2] reported 134 cases which included one enteric case, which was of the jejunal type. Clubbe[3] reported one enteric (ileo-ileal) case in a series of 124; Fitzwilliams'[4] 717 cases included 71 enteric and only four jejunal types; Eliot and Corscaden[5] reported 300 cases with 28 enteric and seven jejunal types; Kassemeyer,[6] 92 enteric cases in a total of 192, with six jejunal types; Perrin and Lindsay,[7] 34 enteric cases in 335 (analysis of these 34 cases was not possible as individual case reports were not presented); Brown,[8] two enteric cases among 31, with no jejunal types; McIver,[9] 12 enteric in a total series of 81 cases (analysis of the enteric types not possible); Reisinger,[10] 13 enteric cases in a total of 38 with but two jejunal types; Close,[11] 11 enteric cases with only one jejunal type in a series of 185 cases; Petersen and Carter,[12] three enteric cases in a report of 64 cases (enteric analysis not possible); Robbins,[13] 34 cases with no enteric types; Mayo and Phillips,[14] 31 cases with no enteric types; Ladd and Gross,[15] five enteric cases in a total of 372 with no jejunal types; Miller and Workman,[16] seven enteric cases in a total of 21 with no jejunal types.

The records of the Cook County Hospital in Chicago were reviewed for a five year period (1931 to 1935, inclusive). Only 32 cases of intussusception

were found, among which there were four enteric types, none of which, however, occurred in the jejunum.

From these statistics it is possible to calculate, with a fair degree of accuracy, the ratio of enteric cases to the total, of jejunal cases to the total, and of jejunal cases to enteric cases (Table I). With a total number of 3,284 cases considered, there were 462 enteric cases (ratio 1 :7), with only 24 jejunal types (ratio 1 :117). In other words, 14 per cent of enteric cases but only 0.9 per cent of jejunal type. When we consider that intussusception is not common, we realize what a small percentage of enteric types occur, and how rare jejunal types are.

TABLE I

RATIO OF JEJUNAL TO GENERAL ENTERIC INTUSSUSCEPTION

Author	Date	Total Cases	Enteric Cases	Jejunal Cases	Ratio of Enteric to Total	Ratio of Jejunal to Total	Ratio of Jejunal to Enteric	Per Cent Enteric	Jejunal
Leichtenstern	1873	593	178	3	1 : 3	1 : 197	1 : 59	33 %	0.5%
Hutchinson	1874	134	1	1	1 : 134	1 : 134		0.7%	0.7%
Clubbe	1907	124	1	0	1 : 124			0.8%	
Fitzwilliams	1908	717	71	4	1 : 10	1 : 179	1 : 17	10 %	0.5%
Eliot & Corscaden	1911	300	28	7	1 : 11	1 : 43	1 : 4	9 %	2 %
Kassemeyer	1912	192	92	6	1 : 2	1 : 32	1 : 15	50 %	3 %
Perrin & Lindsay	1921	335	34	No report	1 : 10			10 %	
Brown	1925	31	2	0	1 : 15			6 %	
McIver	1928	81	12	No report	1 : 7			14 %	
Reisinger	1930	38	13	2	1 : 3	1 : 19	1 : 6	33 %	5 %
Close	1931	185	11	1	1 : 17	1 : 185	1 : 11	6 %	0.5%
Petersen & Carter	1932	64	3	No report	1 : 21			5 %	
Robbins	1932	34	0	0					
Mayo & Phillips	1933	31	0	0					
Ladd & Gross	1934	372	5	0	1 : 74			1 %	
Miller & Workman	1935	21	7	0	1 : 3			33 %	
Cook County Hosp.	1931-	32	4	0	1 : 8			12 %	
Total	1935	3,284	462	24	1 : 7	1 : 117	1 : 17	14 %	0.9%

NOTE: The 1,008 cases reported by Hess: Arch. Pediat., 22, 655, 1905, gave no statistics as to types.

Case Report.—S. R., male, age nine, was first seen by Dr. E. B. Freilich March 6, 1936, complaining of intermittent, colicky abdominal pain for two days with repeated vomiting. He had been in perfect health previous to March 4, at which time the above symptoms began acutely. At the time of examination there was some distension and tenderness in the lower abdomen. No mass was palpable abdominally or rectally, but there was blood on the examining finger. Temperature 100° F., pulse 100. The urine was negative and the white blood count 19,050 with 82 per cent polymorphonuclear leukocytes. A provisional diagnosis or intussusception was made.

Operation.—March 6, 1936, by Dr. Alfred A. Strauss. While under the anesthetic, a tumor could be palpated in the lower abdomen. The mass was exposed through a right rectus incision, and was found to consist of one and one-half feet of gangrenous small bowel, and in addition three feet more of gangrenous small bowel intussuscepted tightly with its mesentery. Because the intussusception could not be reduced, a block resection of the entire mass was performed, and an end-to-end anastomosis was accomplished, using two layers of silk and a few interrupted silk sutures. The patient made an uneventful recovery and was discharged after two weeks.

Gross pathologic examination revealed a double intussusception of jejunum into jejunum and into the first part of the ileum, with extensive gangrene of the jejunojejunal part, which, however, did not involve the ileum. This was confirmed by microscopic

examination. No abnormalities or apparent etiologic factors were found at the apex of the intussusceptum or in the intussuscipiens.

The rarity of this condition, the absence of any etiologic factor, the age of the patient, *etc.*, prompted us to investigate all the cases reported in the literature (Table II).

Sex and Age Incidence.—Twenty-nine cases were found reported from 1852 to 1934. There were 15 males and 13 females; one was not specified. This was particularly interesting, as in the series studied by Perrin and Lindsay[7] the ratio of males to females was 2:1. While it is well known that the large majority of intussusceptions occur under two years of age, in our series the average age was 26.5 years, ranging from four months (Case 29) to 67 years (Case 21) (Chart I).

CHART I

AGE INCIDENCE
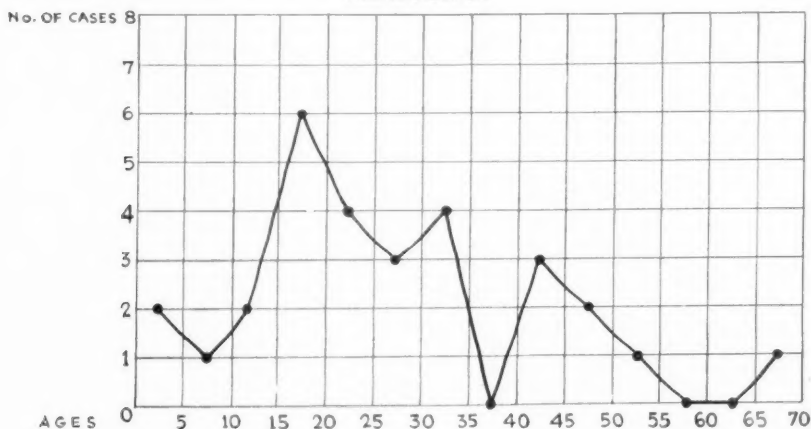
This observation agrees with that of other writers who found that enteric intussusceptions are more common in adults. This being, therefore, an adult type of intussusception, it is interesting to note that our patient was only nine years of age.

In nearly all of these cases the symptoms were chronic in character and had existed over a period of weeks or even years, consisting of vague abdominal pains, or occasional gastro-intestinal upset. Usually, however, there was an acute stage with abdominal pain, nausea, repeated emesis and distension. In 13 cases a mass was palpable either rectally or abdominally, and in only eight cases were bloody stools noted.

Twenty of these 29 cases were operated upon, with six deaths (14 resections and anastomoses with four deaths; six reductions with two deaths). Seven were not operated upon but were diagnosed postmortem.

There were 18 simple jejunojejunal, nine double jejunal and two triple jejunal intussusceptions. Eleven cases were caused by polypi, two by lipomata and one each by a lymphosarcoma, myoma, sarcoma, papillary adenoma, fibro-adenoma, enlarged mesenteric nodes, fibroma, polypoid adenocarcinoma,

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TABLE II

RÉSUMÉ OF THE 29 CASES OF JEJUNAL INTUSSUSCEPTIONS REPORTED IN THE LITERATURE

Author	Date	Sex	Age	Duration	Symptoms	Surgery	Result	Type	Etiology
1. Trevor [17]	1852	M	12	3 wks.	Occ. abdominal pain; acute onset of pain and emesis; palpable abd. mass; negative rectal.	None	Died	Double jejunal	Polyp of jejunum
2. Peacock [18]	1873	F	19	1 mo.	Occ. abdominal pain; anemia; acute onset of abd. pain and emesis; no palp. mass or rectal blood.	None	Died	Jejunojejunal	Polyp of jejunum
3. White [19]	1873	M	30	3 da.	Acute onset of abd. pain, emesis and distension. No mass or rectal blood.	None	Died	Jejunojejunal	Polyp of jejunum
4. Reisinger [10]	1883	M	46	6 mo.	Vague abd. pain followed by acute pain and emesis. Palpable mass in rt. inguinal region. Blood in stool.	None	Died	Jejunojejuno-ileal	Lymphosarcoma of jejunum
5. Whipham & Turner [20]	1891	F	29	3 wks.	Occ. abd. pain and constipation. Sudden onset of pain, emesis, and distension. No palp. mass but rectal blood present.	Reduction	Died	Jejunojejunal with volvulus	Polyp of jejunum
6. Reisinger [10]	1894	F	42			Resection	Died	Jejunojejunal	Lipoma of jejunum
7. Reisinger [10]	1894	F	28		Hyperemesis gravidarum. Abd. mass palpable and rectal blood present.	Reduction	Good	Jejunojejunal	Myoma of jejunum
8. Eliot & Corscaden [5]	1896	F	19	36 hrs.	Pain, emesis, distension and rectal blood; no palpable mass.	None	Died	Jejunojejuno-ileal	Not determined
9. Eliot & Corscaden [5]	1900	F	23	5 da.	Abd. pain, emesis and distension. No rectal blood; no palp. mass.	Resection	Died	Jejunojejunal	Polyp of jejunum
10. Reisinger [10]	1901	M	44	6 wks.	Pain, diarrhea and emesis acutely setting in after vague abd. distress. Rectal blood but no abd. mass present.	None	Died	Jejunojejuno-ileal	Sarcoma of jejunum
11. Maurice [21]	1901	F	23	9 hrs.	Vague abd. pain followed by acute pain, emesis, rigidity and distension.	Resection	Died	Jejunojejunal	Ten polypi of jejunum
12. Reisinger [10]	1902	F	16		Pain in abdomen; palpable tumor.	Resection	Good	Jejunojejunal	Polyp of jejunum
13. Reisinger [10]	1902	M	48		No acute symptoms. Palpable mass.	Resection	Good	Jejunojejunal	Not determined
14. Willard [22]	1907	M	30	7 da.	Obstipation. Acute onset of pain, emesis, distension. tenderness and and rigidity. No rectal blood or palpable mass. W.B.C. 9,000.	Resection	Good	Jejunojejuno-ileal	Subperitoneal lipoma

Author	Year	Sex	Age	Duration	Symptoms	Treatment	Result	Type	Diagnosis
15. Ross & Page [32]	1907	M	17	26 da.	Symptoms of perforation following severe typhoid fever.	None	Died	Jejunojejunal	Not determined
16. Eliot & Corscaden [5]	1908	F	13	40 da.	Occ. emesis and bloody stools.			Jejunojejunal	Not determined
17. Ludlow [24]	1916	M	18	3 mo.	Occ. epigastric distress. Acute onset of pain and emesis. Palp. mass in R.U.Q., but no rectal blood.	Resection	Good	Jejunojejunal	Papillary adenoma of jejunum
18. Oden [25]	1919	M	22	2 yrs.	Abdominal pain and constipation; acute onset with pain, emesis and distension; palpable mass. Roentgenogram showed a prolapsed colon.	Resection	Good	Jejunojejunal	Two pedicled fibro-adenomata
19. Harris [26]	1920	F	1½	24 hrs.	Rectal hemorrhage. and palp. rectal mass; collapse.	Reduced	Good	Triple jejunal	Enlarged mesenteric nodes
20. Louis & Moorehead [27]	1922	M	54	6 yrs.	Recurrent G.I. upsets followed by an acute onset of pain and distension; no palp. mass or rectal blood.	Reduced	Good	Double jejunal	Fibroma of jejunum
21. Green [28]	1928	M	67	6 mo.	Continuous abd. pain; palp. abd. mass in L.U.Q. with negative stools.	Resection	Good	Jejunojejunal	Leiomyoma jejunum
22. Green [29]	1928	F	34	25 da.	Nausea and occ. emesis; acute onset of pain, emesis and tenderness in the R.L.Q. No palp. mass or rectal blood.	Resection	Good	Jejunojejunal	Polypoid adenocarcinoma
23. Thorleifson [30]	1929	M	32	1 wk.	Acute onset of emesis and abd. tenderness with sudden collapse. No palp. mass or rectal blood. W.B.C. 26,900.	Reduced	Died	Jejunojejunal	Not determined
24. Somerville-Large [31]	1929	M	17	20 hrs.	Abd. pain and emesis; palp. mass but no rectal blood.	Resection	Good	Double jejunal	Polyp of jejunum
25. Washburn [33]	1929	M	21	36 hrs.	Emesis, abd. pain and tenderness; palp. abd. mass and rectal blood.	Resection	Good	Multiple jejunal	Multiple polypi of jejunum
26. Reisinger [10]	1930	M	26		Acute pain and distension; palpable abd. mass but no rectal blood.	Resection	Died	Double jejunal	Small tumor of jejunum
27. Reisinger [10]	1930	F	8½		Meteorism. Negative rectal and no palpable mass.	Resection	Good	Jejunojejuno-ileal	Polypus (?)
28. Marr & Marxer [33]	1932	F	40	4 yrs.	Occ. abd. pain and emesis followed by acute onset with tenderness. No mass or rectal blood. Diagnosed by roentgen ray.	Reduced	Good	Jejunojejunal	Polyposis
29. DeTarnowsky & Sarma [34]	1934		4 mo.	4 mo.	Hematemesis; distension; palpable abd. mass; rectal blood; cachexia.	Resection	Died	Jejunojejunal	Infiltrating papilloma

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leiomyoma, infiltrating papilloma, undifferentiated small tumor and by typhoid fever. In four cases the etiology was not determined (Table II).

DISCUSSION.—From the viewpoint of etiology these jejunal cases are very interesting. While only five per cent of all intussusceptions occur in adults, the jejunal types are rarely seen in infants or children. In a large percentage of children with intussusception no demonstrable cause is found, while in the jejunal cases a tumor or some other abnormality of the intestine was the cause in most cases—25 of the 29 cases reported (Table II). If we may consider enteric cases in general, in addition to the above etiologic factors, cases are presented with Meckel's diverticulum,[9] tuberculous ulceration,[35] hemangio-endothelioma,[9] congenital stenosis of the ileum,[46] infectious diarrhea,[36] adhesions,[37] etc., as the cause. It is difficult to account for the cases in which no etiologic factor was found.

Nothnagel's[38] theory of spasm and irregular peristaltic movement in the intestinal wall produced by faradic currents in dogs, Fitzwilliams'[4] explanation of the difference in rapidity of growth in the different parts of the intestinal tract, Alvarez'[39] idea that antiperistalsis may normally occur, and Shaw's[40] theory of peristalsis versus antistalsis as a normal physiologic muscular activity, may all be applicable.

Several theories as to the causation of intussusception in the presence of a tumor in the intestinal wall are advanced. A tumor offers an object which wave like contractions of the circular muscles can grasp and force onward by exerting traction at its point of attachment, pulling it inward and downward, thus initiating an intussusception. On the other hand, the mechanism may be simply that of a spasmodic contraction of the gut around the tumor with inhibition of the gut immediately distal to it, so that the contracted part easily slips into the distal part.

Pathology.—The pathology of acute intussusception is the same regardless of the type. The entering sheath (intussusceptum) is invaginated into the receiving sheath (intussuscipiens). The mesenteric attachment of the invaginated bowel produces great tension on the mesenteric side of the intussusceptum, causing a curve with its convexity towards the mesentery, particularly marked at the apex. This causes a slit like opening in the intestine, with the slit directed towards the mesenteric side of the intussusipiens. The bowel regards the intussusceptum as a foreign body which is violently stimulating its lining mucosa, and is, therefore, constantly endeavoring to establish a contraction ring about it in order to squeeze it along the intestine. The effect of this contraction is exerted along the enteric mesentery with the result that changes similar to those seen in a strangulated hernia develop in the invaginated bowel through which the prolapsed mesentery passes, with the development of gangrene as the arterial vessels are constricted.

For this reason a simple invagination of the bowel that does not constrict the mesentery may result in slight changes in the bowel wall, so that the condition may be tolerated for weeks, months, and even years.

An intussusception artificially produced under normal physiologic conditions tends to reduce itself, and if it is to persist for any length of time, there must be present either some gross lesion in the bowel wall, or some general abnormal condition which increases bowel irritability, upsetting normal peristalsis sufficiently to cause one segment of bowel to telescope into another.

The classical picture of intussusception in infancy is rarely seen in these jejunal types, except in the acute stages of the disease. In most cases a chronic history of abdominal pain, occasional emesis, epigastric distress and constipation may be elicited, followed by an acute onset of abdominal pain, repeated emesis, distension, tenderness and muscle spasm. Collapse may occur as an initial symptom. There may or may not be a palpable abdominal mass, and in only 25 per cent of the cases was there any rectal blood or blood tinged mucus noted.

The treatment of these cases is preferably surgical. Paul Barbette, in 1676, suggested opening the abdomen in cases of obstinate volvulus or intussusception. In 1874, Jonathan Hutchinson[2] performed the first abdominal section with successful reduction of an intussusception. Hipsley,[41] and Koch and Oerum[42] favored the method of reduction by enemata. Arntzen and Helsted,[43] and Retan and Stephens[44, 45] advocated reductions by the instillation of a barium enema. However, the concensus of opinion today favors early surgery.

SUMMARY.—(1) An analysis of 3,284 cases, which include the 32 cases herewith reported from the Cook County Hospital in Chicago, reveals that enteric intussusceptions occur in the ratio of 1:7 (14 per cent), and that jejunal intussusceptions occur in the ratio of 1:117 (0.9 per cent [Table I]).

(2) Twenty-nine cases were found in the literature from 1852 to 1936, and one more case is herewith reported.

(3) Jejunal intussusception, as a rule, occurs in adults and is associated with some definite, local pathologic condition. The symptoms are of a chronic nature, but tend to become acute as the mesentery is constricted giving rise to a clinical picture of obstruction. A palpable abdominal mass or blood in the rectum may or may not be present.

(4) The pathogenesis and pathology of jejunal intussusceptions are discussed in their relation to possible symptomatology.

CONCLUSIONS

Jejunal intussusception is rare, in comparison with those occurring in the ileum and sigmoid colon.

There are certain clinical features which may make possible the early diagnosis of this condition, so that early operation may be undertaken.

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CONGENITAL ATRESIA OF THE INTESTINE

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Congenital anomalies of the gastro-intestinal tract are of interest not only to the embryologist, but also to the surgeon, since successful treatment depends upon early operation. These deformities occur more frequently than is usually appreciated.

The lesions may be classified into those manifesting themselves immediately after birth, and those giving symptoms only in later life.[1] In the first group the atresias, stenoses, and occasionally volvuli are usually the cause of complete obstructions. The malrotations or incomplete rotations, elongated ligaments and volvuli constitute the types in the latter group.

The results obtained in instances of stenoses and artresias are uniformly poor. Davis and Poynter[2] collected 392 cases of congenital occlusion of the intestines, more than 50 per cent of which had multiple atresias from the duodenum to the rectum. None of this group of cases recovered. Birgfield,[3] in 1928, reported 194 cases. Fifty-eight were atresias of the duodenum, 103 of the small intestine, and 33 of the colon. There were only two cases successfully operated upon up to that time; one reported by P. Fokens, in 1910, and another by N. P. Ernst, in 1915.

Since 1900, necropsy has been performed upon 28 cases at the Great Ormond Street Hospital, London, none of which had been operated upon.

The first operative attempt was made by Bland-Sutton.[4] He also contributed much in explaining the possible etiologic factors involved in the production of these deformities.

The first successful operation, by Fokens, was an anastomosis between the separated segments. Ernst's case, in 1915, was an anastomosis between the duodenum and ileum, in which the ileum was brought up over the colon. Richter[5] reported a case successfully treated by posterior gastro-enterostomy. Sweet and Robertson[6] reported an atresia of the duodenum in which the jejunum and stomach were anastomosed. Due to continued vomiting of bile the anterior surface of the second part of the duodenum was joined to the jejunum. Bolling[7] reported three successfully treated cases of duodenal atresia. Duodenojejunostomy was the operation performed in each instance. Webb and Wangensteen,[8] in 1931, stated that there were only nine instances of survival from the operation. There have probably been other operative cures that have never been reported.

Atresias and stenoses of the gastro-intestinal tract are found in one of every 4,000 children. The occurrence of these anomalies in the duodenum

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and small intestine is thought to be one in every 20,000 infants. Stenosis is considered more frequent than artesia, complete occlusion occurring most frequently in the duodenum near the ampulla of Vater.

There is no unanimity of opinion regarding the etiology of these conditions. According to many the obstruction is due to a persistence of epithelial buds in the intestines. Others consider intra-uterine inflammations as being the main cause. Vascular changes are also thought to be a factor.

Loitman[9] classifies the various hypotheses explaining these conditions into two main groups: I. Malformation or arrest in the course of normal development. II. Disease of the fetus.

The following causes come under Group I: (1) Anomalies in the development of the mesenteric artery with consequent malformation of the bowel. (2) Abnormal twisting of the mesentery in the course of normal bowel rotation with occlusion of the blood vessels. (3) Anomalies of development of the vitelline duct. (4) Bland-Sutton's theory that occurrence took place at the site of an "embryological event"; that is, at the site of epithelial outgrowth of the pancreas and liver from the duodenum, a developmental error occurred. (5) Tandler, in 1900, demonstrated from experimental studies that the vaterian segment of the duodenum is occluded by epithelial proliferation during the second month of fetal life. He concluded therefore that in these conditions there was a persistence of these physiologic epithelial obstructions.

Loitman mentions under Group II: (1) Embolus in superior mesenteric artery. (2) Fetal peritonitis. (Fielder, 1864.) (3) Syphilis. (4) Intra-uterine enteritis. (Thorel, 1899.) (5) Volvulus. (Gärtner, 1863.) (6) Intussusception of a loop of intestine with absorption of necrotic bowel. (Chiari, 1888.)

With such a variation of causative factors it is doubtful which play important rôles. There are probably other conditions which play some part in these anomalous conditions.

The symptoms caused by these lesions are those of intestinal obstruction, of which vomiting is by far the most prominent, although it is possible for the condition to exist and this symptom to be absent. The vomiting is usually persistent and for the most part directly associated with the intake of food. The vomitus may consist of only ingested material, or, if it persists and the occlusion is below the ampulla of Vater, it may contain bile. Blood is occasionally present in the vomitus. Scant or absent bowel movement is usual. There may be the passage of some mucoid material from the rectum and occasionally bile may be present in those cases where the obstruction is proximal to the opening of the bile duct. Distention is prominent, the degree depending upon the site of the occlusion, as in all types of intestinal obstruction.

The diagnosis is not difficult, but it is sometimes impossible to localize the site of the obstruction. The greatest confusion occurs in cases with spasm of the pylorus and pyloric stenosis. Vomiting is commonly seen in newborn infants but if it continues some type of congenital obstruction should be

considered. Reversed peristalsis is frequently seen in instances of pyloric stenosis but is not often present in deformities below this site. The vomiting at the onset in pyloric stenosis is often projectile in character but may not be present in atresia. Roentgenologic examination should be made early in these conditions, not only to confirm the diagnosis but also to locate the site of the obstruction. Flat films of the abdomen will reveal shadows of gas. With the child held in the erect position distinct pockets or fluid levels may be seen. The use of barium both by mouth and by rectal clysma may be of aid in

FIG. 1.—(Case 1.) Roentgenogram after barium had been given by mouth and by rectum. The dilated loops of intestine are shown with the blind ends of the ileum.
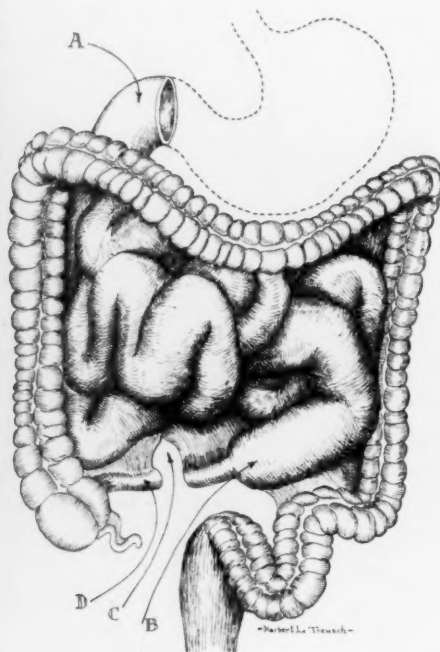
FIG. 2.—(Case 1.) Showing the atresia occurring below the dilated portion of the lower ileum. A hiatus in the mesentery is also to be noted.

localizing the lesion but is not always necessary in the diagnosis. Other congenital deformities, such as imperforate anus, esophageal stenosis, defective rotation associated with volvulus, and internal hernia, must always be considered.

Ladd[10] stressed the fact that examination of the stools may be of aid in determining a complete occlusion. Meconium begins to collect in the intestine after the third fetal month. Any occlusion occurring before this time precludes the finding of the normal elements of meconium in the stools. Keratinized epithelium is the most constant substance and easiest to recognize in the stools. According to Ladd these cells may be seen in the smears dried with ether and stained with Sterling's gentian violet. If these keratinized epithelial cells are not found, it indicates the presence of atresia.

CASE REPORTS

Case 1.—Baby G., female, born December 2, 1935. It was immediately noticed that everything taken by mouth was promptly vomited. The child was full term and apparently a normal infant. A gastro-intestinal roentgenologic series was made 18 hours after birth and showed barium passing through the stomach and duodenum and into the small intestine. There was a large dilated loop of intestine occupying the left upper quadrant of the abdomen. This contained a small amount of barium. A barium enema was given and revealed small streaks along the colon, this was not well visualized but appeared in ribbons (Fig. 1).
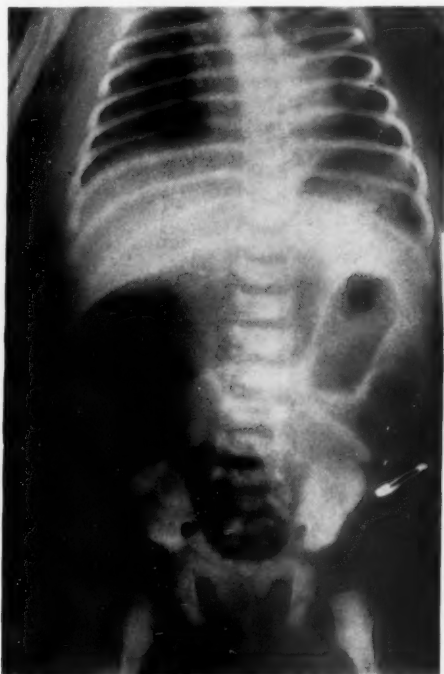
FIG. 3.—(Case 2.) Flat roentgenogram showing the dilated loops of small intestine above the site of obstruction.
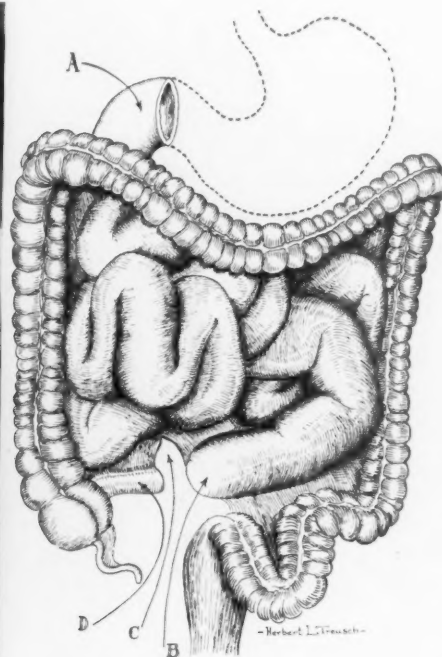
FIG. 4.—(Case 2.) Showing the site of atresia in the lower ileum. The proximal portion is markedly dilated. The defect extends down into the mesentery.

On December 4, 1935, the abdomen was opened. There was a large dilated loop of small intestine which extended from the duodenojejunal junction more than halfway to the cecum. At its distal tip it narrowed to about one centimeter and extended for another six centimeters, where it ended in a blind pouch. There was a definite hiatus both in the gut and mesentery. From this atresia the continuity of the gut began and was normal except for being collapsed (Fig. 2). A tube was inserted in the proximal loop of intestine with no attempt at anastomosing the separated ends. Glucose and saline were given subcutaneously before and after operation. Only a small amount of gas and no fluid drained from the enterostomy tube. The baby died 15 hours after operation.

Case 2.—Baby M. A. C., female, age three days, was admitted to the Henrietta Egleston Hospital for Children after having vomited everything taken since birth. The vomitus consisted of greenish material. The first three stools were soft and mucoid with a greenish tint. The last was dark in color, giving the appearance of bile. The child was markedly dehydrated. The skin was dry and hot. The abdomen was tense and distended, more so above the umbilicus. Peristalsis was visible and active.

A gastro-intestinal roentgenologic series showed the stomach and upper small intestine distended with gas. The bowel terminated in a blunt end in the lower midabdomen (Fig. 3).

An immediate operation was performed after having given glucose and saline subcutaneously. Distended loops of small intestine were immediately encountered. There was an abrupt end of this distended intestine in the lower right quadrant within a few inches of the cecum. There was no communication between the blind ends of the intestines. The large intestine was collapsed down to about one centimeter in diameter (Fig. 4). An enterostomy was performed but no attempt at anastomosis was made. A blood trans-

FIG. 5.—(Case 2.) Roentgenogram after barium enema showing the patency of the large intestine. The ileostomy tube is seen in situ.

fusion was given immediately. Convalescence was very stormy, complicated by dehiscence of the abdominal wound, with an intussusception into the enterostomy. The dilated small intestine acted as a pocket into which the upper limb of the intestine intussuscepted itself. It was necessary on seven occasions to administer ether in order to reduce the intussusception. On many occasions the intestine would prolapse through the stoma and would reduce without manipulation.

After the third week postoperative no attempt was made to replace the dilated loop which was allowed to remain on the abdominal wall. The ileostomy tube came out on the twelfth day postoperative, leaving a fistula in the exteriorized loop of intestine. There was no digestion or irritation of the skin of the abdominal wall from the drainage from the fistula. Several days after operation a barium enema was given, which showed

the barium to flow from the rectum to the cecum (Fig. 5). The caliber of the bowel was small and spastic. One month after the first operation the entire exteriorized intestine was freed and a segment several inches long was resected. The intestine was then anastomosed laterally. Convalescence from this procedure was uninterrupted.

The medical management of this case played an extremely important part in its successful outcome. It is interesting to note that during the seven weeks the infant received a total of 38 subcutaneous injections of Hartman's solution, four blood transfusions, and 5 per cent glucose solution on numerous occasions. Nothing by mouth was given for the first day, then small amounts of water and on the third day a milk formula was started.

It has now been 18 months since the last operation and the child has had no disturbance. She has taken full diet and weight gain has been normal.

COMMENT.—Although these lesions are thought to be infrequently encountered, they occur often enough to reemphasize their importance. If congenital atresia is diagnosed early and adequate surgical treatment instituted, it is possible to avoid a fatal issue. It is believed, in spite of the high mortality rate, that these infants should all be given the benefit of operative intervention.

There is an extremely variable pathologic picture encountered. The presence of multiple stenoses of the small intestine assures practically 100 per cent mortality. It is not always possible to determine at the time of operation if such exists. Above the atresia or stenosis the intestine is usually enormously dilated. The wall is greatly thickened, containing all of the layers of the normal intestine. In the stenosis there is a compression of the wall, giving the appearance of a ribbon. The muscle layers may at times appear thickened. The stenoses are practically complete but occasionally a very small lumen may be seen. In this type of lesion the use of barium as a contrast medium will make the obstruction complete. In the multiple lesions there may be intervening segments of normal intestine. The entire segment is associated with atony. The imperforation in the atresias may occur directly with the dilated loop (proximal), or as in the first case reported, a short distance distal to this point. Very rarely is there a connection between the two blind ends of the gut. When such exists it is a very firm fibrous cord. The hiatus extends not only through the bowel but perhaps into the mesentery. Atresias and stenoses occur usually independent of each other. Multiple atresias are not as commonly encountered as multiple stenoses. Congenital anomalies of the remainder of the gastro-intestinal tract or of other organs may be associated.

Treatment in these cases should always be surgical, before dehydration, alkalosis and demineralization have occurred. The newborn is able to withstand operative manipulations surprisingly well, provided adequate preparation is given. The use of fluids, preferably in the form of Hartman's solution and blood transfusions before and after operation, aids in preventing shock and dehydration.

The procedure carried out must vary with each individual case. Adequate exposure is necessary for complete exploration of the abdominal cavity. This must always be done to determine the multiplicity of lesions; although

shock is associated with evisceration, it is felt that this is essential to examine the individual segments of intestine.

In the two cases reported, palliative enterostomy was the procedure of choice. In both cases signs of complete obstruction were manifested. The proximal intestinal walls were edematous and reddened and a slow decompression was thought advisable. At the same time it was possible to definitely determine that other lesions were not present. Entero-anastomosis is the most desirable procedure but is not always possible. The time required to perform either this anastomosis, or an entero-anastomosis and an enterostomy above, increases the degree of shock in these infants. The shortest and simplest procedure should give the best results, although secondary operations will always be necessary before establishing the continuity of the gut.

SUMMARY

Two cases of single congenital atresias involving the same portions of the small intestine are reported. One patient was operated upon three days after birth with complete recovery. The primary operation performed in each instance was a palliative ileostomy. In the successful case this procedure was later followed by a resection of the portion of the intestine with lateral anastomosis. It became necessary to do this due to a chronic intussusception developing in the stoma of the ileostomy. A review of the more common theories of formation of these peculiar anomalies is given. The preliminary and postoperative administration of glucose is advised. Hartman's solution and blood transfusions plays an important rôle in the successful treatment of these conditions. Early operation should be performed in all cases of complete stenosis and atresia. When vomiting in the newborn becomes persistent, congenital gastro-intestinal lesions should be suspected and ruled out if the only opportunity for recovery is to be afforded the infant.

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RECTAL PROLAPSE

EXPERIENCE WITH THE ELASTIC LIGATURE

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So many procedures for the treatment of rectal prolapse have been advanced that it was thought worthwhile to report our very satisfactory experience in three cases treated by the very old and simple method of elastic ligature, recently rediscovered by Mont Reid[4] and further reported upon by Owen Wangensteen.[5] -Weinlechner,[6] in 1883, was the first one to use an elastic ligature, though Copeland, Howship, Busche and Greenhag had employed the same principle using different material such as silk, catgut, *etc.*

Weinlechner's first case was in a child of eight months. It was an operation of necessity as the prolapsed rectum had been torn in attempting to replace it. The method employed was simply the occlusion of the blood supply to the prolapsed portion of the rectum by means of an elastic ligature tied over a stiff rubber tube introduced into the rectum. The rectum healed satisfactorily after four weeks. In 1886 he[7] reports three similar cases treated in the same way with good results. Following this, use was made of the method by von Albert, Allingham, Blandin, Hofmokl, Kleebarg, Marchal and Mikulicz.

Bakes,[1] in 1900, reports three cases; two were very satisfactory but the third died of peritonitis. At autopsy the cause for the peritonitis was found in a perforation at the site of the elastic ligature. He advances two reasons in explanation of this catastrophe. First, the elastic ligature was apparently drawn too tightly so that it cut through before firm serosal adhesions had formed, and secondly, before ligation undue traction was placed on the prolapse by means of a bullet forceps. This is the only mortality which was found recorded in the literature.

Kleebarg, in 1879, employed a similar method but simply used the elastic ligature as a means of hemostasis until he had amputated the prolapse and sutured the contiguous margins. Matas in discussing Reid's paper, in 1933, described a case in which he had used a similar procedure with success in 1894. Amputation of the prolapse was popularized by Mikulicz[3] and, in 1889, he reports seven successful amputations without a mortality. However, Lenormant, in 1907, states that the danger of peritonitis is at least 10 per cent.

With the advent of antiseptic surgery, this method fell into disuse, though one case is reported by von Serafini in 1906. Bauer,[2] in 1912, in a very comprehensive and excellent paper on the treatment of prolapse, stated that the cause for discontinuance of this method was the severe pain after the application of the ligature, retention of urine and difficulty in expelling gas.

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Since its rediscovery by Reid in 1925, four cases have been reported by him and one by Wangensteen with good end-results and without any of the above mentioned unpleasant symptoms. This has also been our experience in the following three cases:

Case 1.—G. O., male, age 40, was admitted to the University Hospital in December, 1933. For some time prior to October, 1933, he had been constipated. One day he noticed a protrusion of his rectum which he replaced. This recurred at the next bowel movement, and at each succeeding one, so that he was unable to obtain a satisfactory evacuation. This difficulty increased up until the time of admission. His rectum would prolapse without the slightest amount of straining.

On examination a prolapse of about five inches of the rectum was seen. There was no etiologic explanation for its occurrence. In every other way he appeared to be in the best of health. Operation was decided upon and because of the absence of any etiologic factor it was thought better to perform a laparotomy. At the same time the possibility of performing a Moschowitz operation—obliteration of the culdesac of Douglas—was kept in mind. The depth of the culdesac would have made this operative procedure exceedingly difficult, so that removal of the prolapse by means of an elastic ligature was decided upon.

With the peritoneal cavity opened, we were also able to be absolutely certain that no loop of small intestine was contained in the prolapse. At operation, the rectum and sigmoid appeared to be perfectly normal. The prolapse readily recurred even under an inhalation anesthetic. With the hand in the abdomen, traction was made on the prolapse until all the redundancy of the sigmoid had been taken up. The small intestines were then packed out of the pelvis. In order to be certain not to injure the urethra a sound was introduced into the bladder. A firm rubber tube about three-quarters inch in diameter was inserted into the rectum for a distance of eight inches. A heavy rubber band was placed near the mucocutaneous junction, tightly encircling the prolapse. The prolapsed rectum rapidly became cyanotic and the next day was gangrenous. Thirteen days after operation, following an attempt to remove the slough, the patient had a profuse hemorrhage which stopped spontaneously. Three days later he expelled both the tube and the slough. At time of discharge, 22 days after operation, rectal examination revealed a normal rectum with slight relaxation of anal sphincter.

Follow Up.—He was not seen again until four months later when, much to our chagrin, he returned with a stricture which admitted only the tip of the index finger. This was gradually dilated. Due to failure of complete cooperation on the part of the family physician, the stricture recurred two months later. It was again dilated and the patient kept under close observation. When last seen, one year and three months after operation, the stricture readily admitted the middle finger and the patient was quite comfortable.

Case 2.—R. J. B., white male, age 41, was an inmate of the Philadelphia Hospital for Mental Diseases, suffering from schizophrenia. He was admitted to the Philadelphia General Hospital May 25, 1935, with a prolapse of the rectum in which palliative treatment had failed during the preceding several weeks. In 1932 he had had a prolapse which had been treated by linear cauterization.

Operation.—May 28, 1935. Under gas anesthesia the patient's colon was thoroughly irrigated—and the anal sphincter stretched. A thick, stiff, rubber tube was inserted to just above the external sphincter and fixed in place with two silk sutures to the prolapsed rectum. A flexible rubber tube was then twisted about the mucocutaneous junction and fixed with two silk sutures. The prolapse was dressed with vaseline and dry gauze. Despite restraint on the night of operation, the rectal tube was found in bed with sutures

torn out. An elastic ligature was reapplied on May 30, 1935. On June 6, 1935, the prolapse sloughed off, following a bowel movement, leaving a clean surface.

Follow Up.—Examination one year later, April 1, 1936, revealed a normal rectum, without stricture and no evidence of recurrence.

Case 3.—H. C., female, age 45, had had a prolapse of the rectum for the past ten years. Originally the prolapse occurred only when at stool, but it gradually began to occur more often and became larger. She had a laparotomy in 1931 to correct the condition, but the operation was a failure.

Physical Examination revealed an obese woman, apparently well except for a prolapse of the rectum, when straining. The prolapse did not include the entire thickness of the rectal wall but apparently only involved the mucosa. On straining the mucosa covering the anterior wall of the rectum appeared at the anus and gradually prolapsed until the entire circumference of the bowel was involved.

Operation February 19, 1936. Under gas anesthesia, a large rubber tube was placed in the rectum and the prolapsed mucous membrane pulled down as far as possible; it was then strangulated by a heavy rubber band. The mucous membrane was prevented from retracting by suturing it to the rubber tube. Ten days later the strangulated portion sloughed off, leaving a clean granulating surface.

Follow Up.—Care has been given in the Proctoscopic Clinic, which consisted of weekly dilatations. Examination four months after operation showed a completely healed rectum with a thin membrane at the site of amputation. This readily admitted middle finger. The patient had no complaints.

DISCUSSION.—In Case 1 two complications were encountered, namely, hemorrhage and stricture. The only suggestion that might be of value in avoiding hemorrhage is the fact that it followed manipulation of the strangulated portion of the rectum. Probably hemorrhage would be a less frequent complication if separation were allowed to occur absolutely spontaneously. One should be able to prevent the formation of stricture by close follow up care as shown in the last two cases. Case 2 was an ideal test as the patient was mentally unable to extend any cooperation whatsoever. In spite of this fact there has been no recurrence and result has been entirely satisfactory.

Naturally this procedure is not recommended in all cases of rectal prolapse. Especially in children, which comprise 70 per cent of all cases, more conservative measures should be given a trial. However, in certain cases it seems as if this method were a definite addition to a surgeon's armamentarium. Irreducible prolapse with infection of the prolapsed portion is the strongest indication for its use, but as shown by the three cases reported herewith, this method can be used with advantage in prolapses which are less far advanced. The published reports show that there is no danger of recurrence whereas other operative procedures give an incidence of recurrence varying from 6 to 15 per cent. The danger of stricture is a real one, however, and must be guarded against by close follow up care in these patients. Wangensteen suggests the use of antigas serum prophylactically, which may be a worthwhile procedure.

<div align="center">SUMMARY</div>

(1) Three cases of rectal prolapse are presented treated by the strangulation method by means of an elastic ligature.

(2) Good end-results were obtained in all three.

(3) The danger of stricture as a complication is emphasized.

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TUMORS OF THE UTERUS *

WITH SPECIAL REFERENCE TO FIBROIDS

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THE fibroid bearing woman is not, of necessity, a surgical entity. Eliminating those tumors which should be treated by roentgen therapy or radium, operation is not, and should not be, advised unless one or more of the conditions mentioned subsequently exists in the patient under consideration.

As I am now dealing with the surgical consideration of fibroids I eliminate in this contribution all reference to the use of radium or roentgen ray, although I admit the value of these agents in certain cases. Owing to the infrequent occasions on which we find fibroids have become sarcomatous or carcinoma is associated with fibroids, the malignant argument should not be used as a whip to force the patient to operation without explaining the low incidence of carcinoma in this condition. The possibility of malignant degeneration is never mentioned by me to my patients unless they bring up the argument. I then frankly tell them of the infrequency of fibroids degenerating into a malignancy. The arguments I do use in advising an operation are those covering anemia from the loss of blood, the possibility of irritation, degeneration and necrosis. I advise operation in all symptom bearing cases, those with multiple tumors, irrespective of size, and those with single tumors which are over the size of a three and one-half or four months' pregnancy.

I concede that the radical removal, subtotal or total hysterectomy, prevents conception. The same applies when radium or roentgen therapy is used. However, the operative procedure has the advantage over treatment by radium or roentgen ray, in that the patient is not thrown into a sudden, complete menopause. Roentgen therapy and radium destroy all function of the ovaries, whereas an operation always presents the opportunity to save one ovary or both if, on examination, either one or both presents a clinically healthy appearance. By retaining one or both ovaries together with the tube or tubes the manifestations of menopause will be held in check for a time and will not, therefore, be so acute.

Some of the symptoms that call for the operation argument are:

(1) Excessive bleeding, frequent or irregular bleeding, intermenstrual leakage or "shows."

(2) Urinary frequency, nocturia and dysuria.

(3) Gastro-intestinal distress, chiefly observed following a fair sized meal, which is often due to the limited intra-abdominal space caused by the displacement of the growth.

(4) Pressure symptoms which include backache if it can be proved that

the backache is not due to other sources such as osteo-arthritis, inflammation or other pathologic intra-abdominal sources; pelvic pain produced by pressure on the lumbar and sacral plexuses; edema of the extremities as seen in some of the large growths, the result of pressure upon the return circulation.

(5) Recurring attacks of pain simulating peritonitis and perhaps due to friction between the tumor and the abdominal contents or the parietal peritoneum.

(6) Rapidly growing tumors, which always convey the idea of degeneration, usually myxomatous, although they may be malignant.

(7) Twisting of a pedicle in the pedunculated variety, which demands exploration before a positive diagnosis of twisted pedicle may or can be made.

(8) Exceptional size in a symptom free growth, forcing the patient to come to the surgeon and solicit an operation, to check the remarks of neighbors and friends, especially if the patient is unmarried or widowed.

(9) Cardiac changes with or without definite blood pressure increase.

(10) Anemia and dyspnea.

(11) Necrosis or sloughing.

(12) Mental distress after the diagnosis of a tumor has been made.

Myomectomy is always forcefully presented to the woman who desires a child, although I never permit a patient to leave the office before she fully understands that she must give her consent for the operation which is considered best for her when the uterus and its tenant or tenants are exposed.

It is interesting to note that myomectomy is followed in many instances by the further involvement of the uterus with fibroids, usually within five to ten years of the time of the original operation. This involvement necessitates an hysterectomy. I recall an instance when a specimen removed by myomectomy was reported as being benign. Three years later a removal of the uterus and the adnexa was necessitated for a malignancy at the site of the myomectomy scar. There is no question in my mind but that a fibroid predicates more tumors in the body structure. This is easily demonstrable on section of the uterus as numerous small patches are seen in the walls which sooner or later may reach a size that may be easily palpable and which will require surgical intervention. Nevertheless, we naturally desire to save the uterus in a young woman who is anxious to bear a child. Myomectomy is in order, when possible, even with the likelihood of a second operation at a later date.

Carcinomatous degeneration of fibroid tumors has not been seen by me in over 1,700 operations. Sarcoma of the uterine tumor has been reported in several instances.

Carcinoma or sarcoma may involve the musculature in the immediate vicinity of the fibroid or fibroids. The operative treatment, admitting a small operative trauma to the surrounding structures, has many advantages over the institution of roentgen or radium therapy, especially in members of the working class. In other words, it is much more economical as to time. The operation and repair, in all cases healing by primary intention, allow a

patient to be discharged from the hospital on the fourteenth postoperative day with an early return to work, as a rule. Compare this with the drawn out period of radiation treatments, although more recently roentgen therapy is able to provide an earlier result.

The operation as performed by me is the Kelly, from above down, *etc.*, with a few modifications. After the vaginal canal has been thoroughly iodinized, we are careful to see that the iodine swab has entered the posterior fornix; a catheterization and dry abdominal shave are usually done while the patient is being anesthetized; 3½ per cent tincture of iodine is then applied to the abdomen, the application extending up to the ziphoid cartilage so that if stones are found in the gallbladder, on palpation, this organ may be removed, provided the patient's condition permits.

After the abdomen is opened, the uterus or the tumor is seized with a long volsella forceps or a corkscrew. Artery clamps are placed on the broad and round ligaments, one juxta-uterine, the other lateral. I then cut between them and follow down in this manner until the cervix is reached. The last pair of clamps grasps the uterine artery. The peritoneum and bladder are pushed down on the cervix by cutting transversely from the clamped side to the opposite side and the cervix is then cut through to the uterine artery of the opposite side. If care is taken this artery may be seen on the other side. With the cervix cut across the artery and broad ligament are then clamped from below upward and cut, proceeding upward in this manner until the broad and round ligaments have been entirely cut through. The cervical canal is then carbolized or reamed out.

In the subtotal operation a running catgut suture, beginning where the uterine artery has been tied, is then applied through the broad and round ligaments enclosing the clamp. As the suture reaches the end of the clamp bite the clamp is removed and the suture drawn and tied with the end of the uterine artery ligature. This method of suture is continued over the clamps until the entire broad ligament is sutured. The sutured broad and round ligaments are then attached to the cervical stump and the ligaments on the opposite side are then sutured in the same manner. The peritoneal toilet is completed by approximating the ligaments over the cervical stump together with the peritoneum associated with the bladder. I cannot too strongly advise thorough hemostasis of the round ligament, although the late Doctor Baldwin, of Columbus, Ohio, has stated that "the blood supply of this structure is of no importance." I have seen a hemorrhage within a few hours after an hysterectomy which required a transfusion and a reopening of the abdomen. The bleeding point was easily seen in the middle of the round ligament.

When doing a complete operation the method of procedure is the same up to the point where the uterus has been removed. The next step is the pushing of the peritoneum and the bladder down from the cervix and the vagina, so that a transverse incision may be made into the vaginal vault and the anterior lip of the cervix grasped with a pair of double-toothed volsella; then the

cervix is rotated on its transverse axis and is ablated from the vagina. After ablation the vaginal wall is sutured. This stops the major portion of the oozing. With the vault closed, we proceed with the broad and round ligament sutures as in the subtotal operation. Finally, the stumps are attached to the sutured vault and the peritoneal toilet completed.

It is my custom at the operation to perform a complete hysterectomy on every patient with a lacerated cervix. This is primarily because of the disagreeable leukorrhea, persistent in many patients in whom the cervix is retained, and, secondly, because of the possibility of malignant degeneration in the retained cervix. This malignancy occurrence is rated from 0.2 to 3 per cent of all retained cervices although this percentage does not present to me a minimal possibility, as will be shown later. Based upon the malignancy argument I would advise the occasional operator to perform a subtotal hysterectomy with reaming out or cauterizing of the cervical canal.

I am in the habit of leaving the adnexa in a patient under 48 years of age, provided she is not in, or finished with, the menopause at the time of operation. Formerly I left the ovaries or an ovary, being careful to sacrifice the tubes for fear of a hydrosalpinx at a remote period. Now, if there is no visible gross lesion of either ovary or tube, great care is taken to retain these organs.

I am satisfied that in the past ten years, in my experience with this procedure of conservation, the menopause onset is delayed or not so profound as it was in the patients in whom I formerly sacrificed the tubes. Further, in follow-ups on these patients I do not have any secondary operations for cysts or similar growths which would cause me to change my procedure. This clinical feature may only be explained on the grounds of retained nerve and vessel supply when conservation of the tubes is practiced. Naturally, if the adnexa are obviously involved they are removed.

It is also my procedure to investigate carefully the gallbladder and to remove the appendix when present. The gallbladder is either removed if it contains stones, or the knowledge of the presence of stones is transmitted to some member of the patient's family with instructions as to future intervention.

While I am not strongly disposed to argue malignancy as a resultant of cholelithiasis I cannot but recall a patient, operated upon some years ago, on whom I had made a record at operation of three fairly large stones in the gallbladder. The gallbladder was not removed at the time of the hysterectomy on account of the patient's condition at the time. She was informed of the findings and of the advisability of an operation at a later date. I never saw her after her discharge until five years after the hysterectomy. She was then complaining that her gallstones had been working overtime for about three months and that she had a very tender lump in her right side. Upon examination it was first supposed that she had an acute cholecystitis, but when under anesthesia a definite nodular mass was readily felt the diagnosis

was changed to malignancy as a possibility. Abdominal section revealed an inoperable carcinoma of the gallbladder with hepatic metastases.

In an article published in Surgical Clinics of North America, April, 1928, I summarized my operative cases as follows: From January, 1917, to January, 1927, I had performed 495 subtotal hysterectomies with five deaths, 214 complete hysterectomies with three deaths or a total in the ten years of 709 operations with a mortality of eight. Previous to that period I had reported 334 hysterectomies with two deaths so that in a total of 1,042 hysterectomies with ten deaths the mortality was less than 1 per cent. Of these ten deaths three were operations following the use of radium or roentgen therapy.

From January 1, 1927, until January 1, 1936, a period of nine years, I have a record of 664 operations with 11 deaths, a mortality of 1.65 per cent. Of this number 320 were subtotal hysterectomies and the remaining 291 were complete hysterectomies. In this series there were 44 cases of cholecystitis in whom a cholecystectomy was performed in 39, none of whom died. In the other five cases stones were found in the gallbladder, but for various reasons it was not removed. Appendicectomy was performed in 538 cases. There were a number of cases recorded from whom the appendix had been removed previous to the operation for fibroids.

My reason for operating upon the gallbladder in these cases is due to the fact that in several instances I have had to consider an acute cholecystitis in a postoperative convalescence. Therefore, when conditions are favorable I remove the gallbladder.

An appendix left after an operation upon the uterus has given many of us more surgical occupation and worry than it would have if it had been removed at the time of the primary uterine operation.

In these 664 patients, of the past nine years, carcinoma of the body of the uterus was found in 24 instances and carcinoma of the cervix was found four times. Sarcoma was found twice. A myomectomy was performed in 35 instances.

As I have stated before, a subtotal hysterectomy was performed in 320 instances. Carcinoma of the remaining cervix in these cases occurred but twice, none in the first two years, so that the percentage is less than two-thirds of 1 per cent. I admit that for various reasons all of our patients do not return to us. Some move away, some are discontented with the operator after his bill has or has not been paid, and then there have been one or two who have had an injury to the bladder or ureter and have not cared to return. Out of these 320 in whom the cervix has been retained, quite a few, although as I have stated no records have been kept, have returned complaining of a simple or foul leukorrhea. It is for this reason and not the malignancy incidence that I advocate the complete operation.

Of this series there were 574 patients who had been married, not all of whom had had children, and 90 patients who were single, several of whom had had a child or had had an abortion.

One of my patients, whom I am not including in my mortality incidence,

had an acute tuberculosis together with a fair grade of diabetes for which she had been taking insulin for several years. On examination the cervix was found to be the site of a malignancy. A complete hysterectomy was performed. Several weeks later a tubercular meningitis developed, from which she died.

Pregnancy was found in 14 instances, one of which was extra-uterine. This may seem to convey the idea that our diagnostic ability was at fault or that gullibility is, or was, a great factor. Several of these pregnancies were found in myomectomy cases. One case I have particularly in mind was a woman with an evident four and one-half months' pregnancy in addition to three subserous fibroids, each as large as a cocoanut and each readily removed. The patient went on to full term with complete recovery after myomectomy of the three fibroids. Another of my patients had denied all possibility of pregnancy and insisted she had had a full menstrual flow within 18 days of her operation. Unfortunately my gullibility precluded an Aschheim-Zondek test. To add to my chagrin I operated upon this patient before a visiting group of the American Association of Obstetricians, Gynecologists and Abdominal Surgeons.

All of these pregnancy cases were operated upon for fibroids in excess of the size of the pregnancy, the latter condition being known or suspected in the majority of instances.

In one of my patients, an unmarried woman under forty, a carcinoma of the sigmoid was found after completing the toilet of the peritoneum and removing the walling-off pack. The abdomen was closed and reopened three weeks later, at which time a sigmoidectomy was performed.

My mortalities have included pneumonia, embolus, peritonitis (diagnosed by the pathologic department on autopsy, because a bit of bloody serum was found in the pelvis, but this was disputed by me), anemia and dehiscence of the wound. There was one patient who died because she said she would die and would not lend herself to treatment or cooperation. No cause was recorded as a result of the autopsy.

About five years ago I operated upon a young woman, age 22, in a suburban town for multiple fibroids of the uterus and a pathologic appendix. A complete hysterectomy was performed, retaining both adnexa, and the specimen sent to the State laboratory. It was reported back as malignant leiomyoma of the uterus. This patient lived for almost four years after her operation. The pathologist at the Post-Graduate Hospital made a report on the specimen of extensive spindle cell sarcoma of the uterus.

OPERATIVE COMPLICATIONS.—In my operations upon the uterus during these past nine years I have found the following conditions added to, or associated with, the tumors of the uterus: carcinoma of an ovary or both ovaries was found in nine instances and in all these cases both adnexa were removed. A carcinoma of the stomach was found in one case for which a Pólya anastomosis was performed two weeks following a subtotal hysterectomy. Nephrectomy was necessitated in two instances, one for a carcinoma

and the other for an hydronephrosis. Carcinoma of the rectosigmoid was found in four instances, one with an implantation at the cervicocorporeal junction for which a sigmoidostomy was effected, a Mikulicz operation in another and a resection in the other two cases. Ten inches of the ileum were resected in another instance because of dense attachments due to carcinomatous invasion. Carcinoma of the rectum was found in one case but the patient died of pneumonia subsequent to the operation for fibroids. There were two cases of mastitis and one case of carcinoma of the breast, a simple excision being done in the first two instances and a complete amputation in the case of carcinoma. In the spring of 1934 I removed a tumor weighing 15 1/8 pounds from a bride of a few months who was at that time 32 years of age. A frozen section on the specimen sent to the pathologic laboratory was reported back as leiomyosarcoma, apparently slow growing. Four days later the final report from the laboratory was received, giving the diagnosis as leiomyoblastoma showing excessive growth energy. The pathologist added the note that the patient should be carefully observed for possible recurrence in the pelvis or metastasis to the lungs. She returned for a general check-up in January of this year, about 19 months from the time of her operation, and reported as being in fine condition. Examination at this time was absolutely negative as to any recurrence. She reported May 5 of this year that she was still in excellent health.

Leiomyoma was reported in 128, fibroma in 484 and adenomyoma in 13 instances in this series of 664 cases.

In one of my patients, upon whom a subtotal hysterectomy had been performed, I opened the sigmoid and bladder on account of dense attachments. The opening in the sigmoid healed promptly leaving a vesicocervicovaginal fistula which was repaired successfully after two attempts. The fistula admitted a very small bougie into the bladder through the cervical canal.

I have had another case of a vesicovaginal fistula following a complete hysterectomy. This was repaired during the eighth postoperative week.

Another of my patients had a tumor with an added pregnancy so that the mass was equal to about three and one-half months. She denied the associated pregnancy. A complete hysterectomy was done. She was in excellent condition until the eighth or ninth day following operation. During that time she had passed from 250 to 600 cc. of urine at a time. On the eighth day the urine was blood tinged and on catheterization on the ninth day 1,500 cc. of clear urine was obtained. From that day she has leaked a great amount of urine. It has not been possible to corral her for cystoscopy and operation.

As before stated, I have never found one patient in whom I had performed a second operation for a cystic ovary or for salpingitis in those patients in whom the adnexa have been saved. In the spring of 1935 one of our surgeons said he removed a cyst in the case of a very prominent woman whose records, both those of the hospital and my own, showed that a sub-

total hysterectomy and a bilateral oophorectomy had been effected at the time of her original operation. She was 63 years of age when I operated upon her. The question arises as to an aberrant ovary which had become cystic.

The majority of young women to whom operation has been advised have raised strong objections to the possibility of the development of corpulency after a hysterectomy, the development of a deep bass voice, the development of hair over the face and body and the loss of sexual desire. I have been able to convince these patients that all these fears are without foundation.

Let us now consider the retained cervix. I have never been enthusiastic about the retained cervix as a potential source of cancer, any more than I have been impressed with the statement that all lacerated cervices are liable to malignancy. One of the most vicious carcinomas of the cervix that I have seen was found in the bride of a physician. She had been married but a few months and had not been pregnant. No instruments had ever been used on her. She had a history of unusual bleeding and was referred to me by her husband. The examination revealed a soft, fungating growth. A biopsy was taken and reported back by the pathologists as a highly malignant growth. Actual cautery of the cervix and body by the Byrnes' method was done, followed later on with a transabdominal removal. Extensive abdominal metastases followed with death occurring in less than nine months.

I accept the dictum that a badly lacerated or ulcerated cervix with everted lips is a case for repair, and is more liable to a malignant change than a nonlacerated cervix. Following along this argument I quote the following from an article by Dr. Lillian K. Farrar, published in the April, 1935, issue of Surgery, Gynecology and Obstetrics: "Total abdominal hysterectomy avoids the danger of leaving a diseased cervix or an unsuspected carcinoma in the cervix." In a most meticulous article Doctor Farrar has not quoted her percentage of malignancy in the retained cervix but cites the figures of Chrobak of the University Clinic of Vienna who reported three cases of cancer that had developed in the stumps of cervices several years after a supravaginal hysterectomy had been performed. Masson at the Mayo Clinic reported 29 cases seen in five years. He did not state how many had been retained. "In the Woman's Hospital the incidence of carcinoma developing in the cervical stump one or more years after a supravaginal hysterectomy is 7 per cent of all patients who come to the clinic for treatment of carcinoma of the cervix." Hence the incidence of malignancy in the retained cervix must be small.

Dr. Edward H. Richardson, of Baltimore, in an article on "Total Versus Subtotal Hysterectomy," The American Journal of Surgery, June, 1935, states: "I would unhesitatingly conclude that the occurrence of stump cancer is so rare as to be a negligible factor in this discussion. The average incidence subsequent to approximately 10,000 subtotal hysterectomies reported by a dozen different authors is a little less than 1 per cent." He further states "the practice of coring out the mucous membrane of the cervical canal

at the time of subtotal hysterectomy or destruction of it by heat, applied in one form or another, has been emphasized by some surgeons and adopted by a considerable number as a reliable safeguard against the subsequent development of stump cancer. But when it is recalled that more than 80 per cent of all cancers of the cervix originate from the squamous epithelium of the portiovaginalis, it becomes evident that this procedure has only a meager prophylactic value. On the other hand, the majority of stump cancers appearing within one year after subtotal hysterectomy are adenocarcinomata and since these are assumed to coexist at the time of the operation it becomes evident that the block of cored out cervical tissue possesses particular value for immediate biopsy by the frozen section technic. Two other points of practical importance appear to have been established through statistical studies which need to be emphasized because they are in conflict with prevailing surgical opinion: (1) that approximately 10 per cent of these stump cancers occur in women from 20 to 35 years of age; and (2) that over 20 per cent of these women have never been pregnant.

"The latter point serves to focus our attention sharply upon the possible rôle which chronic infections of the cervix play in the etiology of cancer, since a considerable proportion of stump cancers follow subtotal hysterectomies performed because of the late consequences of uterine and adnexal infections. Furthermore, it has been abundantly demonstrated that such infected cervices are etiologically responsible for at least a small proportion of the cases of infection arthritis. Chronic leukorrhea, which is so prevalent as to be accorded but scant consideration by the average doctor, is the sign that points unmistakably to the existence of these lurking menaces. Consequently, the teaching of those who emphatically condemn subtotal hysterectomy in the presence of chronic infection of the cervix is unquestionably sound."

In an article by Dr. Erle Henriksen of the Department of Gynecology at Johns Hopkins Hospital, "Carcinoma of Cervix Uteri," Archives of Surgery, June, 1935, he states: "If the growth appears after a period of two years it is considered a new growth; with this rule the percentage of carcinoma in the stump is reduced to less than 0.2 per cent. The growth may be assumed to have been preexistent if it occurs within two years after the operation. This low percentage can be further reduced if, during the surgical removal of the uterus, the cervix is either cauterized or repaired as indicated. If the growth appears before two years it is considered to have been present at the time of the operation but to have been overlooked." He summarizes that 22 cases occurred in the cervical stump following subtotal hysterectomy but does not mention the number of subtotal hysterectomies performed, with an average lapse of five years.

SUMMARY

(1) That fibroids under three and one-half months' pregnancy size are benefited by the use of roentgen therapy or radium in many instances.

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(2) That fibroids up to four months' size and larger, if nonsymptom bearing, may be kept under observation.

(3) That the incidence of carcinoma of the left-in cervix is so small that a subtotal hysterectomy is acceptable in many patients.

(4) That all lacerated cervices with eversion of the lips, infection and ulceration should be removed. In other words, a complete hysterectomy should be performed to prevent the possibility of a carcinoma, small as the percentage may be, and to prevent the nuisance and undesirability of an obnoxious leukorrhea.

(5) That patients should be impressed with the fact that fibroids do not degenerate into carcinoma or sarcoma, thereby allaying their fears and reducing the cancer phobia. Cancer argument should not be used as a whip to operation.

(6) That the carcinomata of the left-in cervix after the first year are primary carcinoma.

(7) That carcinomata of the left-in cervix in the first year are, in all probability, carcinomata which have been overlooked at the time of operation.

PRIMARY CARCINOMA OF THE MALE URETHRA

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Although it is a well recognized fact that the urogenital tract does show a striking inherent predisposition to the development of neoplastic growths, the one portion which does not manifest this peculiar tendency, except in rare instances, is the urethra. The authors are cognizant of the intrinsic value of the report of such a rare pathologic lesion as primary carcinoma of the male urethra but feel that there is further justification for this additional contribution to the literature which is fast becoming replete with similar case reports in the fact that further emphasis should be placed upon the early diagnosis and prompt treatment of this disease.

Case Report.—H. S., age 66, married, white, male, Jewish, tailor. Admitted to Sinai Hospital September 21, 1932, complaining of pain in the penis, an urethral discharge and swelling in the scrotum.

The patient had always been in good health until onset of present illness two years ago. He gave no history of gonorrhea or syphilis. He first consulted a physician about the middle of June, 1932, because of an urethral discharge and pain on urination. At that time there were no other urinary symptoms. He was treated at another clinic where he received anterior urethral irrigations of potassium permanganate and "several" dilatations for "urethral strictures." A large right hydrocele, the size of a grapefruit, was tapped.

He was admitted to the Genito-Urinary Clinic of the Sinai Hospital August 12, 1932, complaining of pain and difficulty in voiding, burning and urethral discharge. Smears of the urethral discharge showed many pus cells and small bacilli. Examination with an olivary bougie and filiform and followers revealed a stricture of the anterior urethra 3 cm. from the external meatus and another stricture in the membranous urethra.

On September 20, 1932, complaining of pain on urination, pain in the penis, discharge of blood and pus from the urethra, and fever, he was admitted to the hospital. There were no symptoms or complaints referable to the cardiac, pulmonary, gastrointestinal or neuromuscular systems other than a loss of strength and weight.

Physical Examination.—The positive findings were limited to the inguinal, genital and rectal examinations. There were two large nodes about the size of hazel nuts present in the left inguinal region near the external ring and several small nodes, each of the size of a pea, in the right inguinal region. No herniae were present. The right side of the scrotum was enlarged to the size of a grapefruit due to the presence of an hydrocele of the tunica vaginalis of the right testicle. On rectal examination, the prostate was found to be enlarged (first degree), soft and elastic in consistency and globular in form.

The penis appeared to be of normal length but was deviated to the right. At the external meatus there were two openings; the upper was a false opening; the lower, situated immediately underneath, was smaller and represented the urethral meatus. A blood tinged purulent discharge was present. When the discharge was wiped away, a small piece of granulation tissue was seen protruding from the external meatus. For a distance of 7 cm. from the external meatus, the penis including the glans and the

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corpora cavernosa appeared to be enlarged and annular in shape. At the point of greatest swelling, which was 2 cm. behind the coronal margin, the penis measured 9 cm. in circumference. The skin was tense and reddened. The entire area was tender
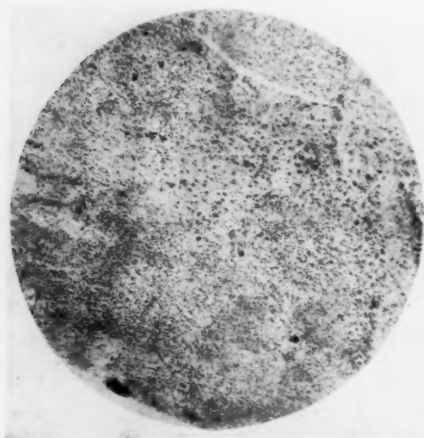

FIG. 1.—Photomicrograph of necrotic tissue removed from corpora at the first operation. Marked inflammatory and necrotic changes are readily detected. In the center of the necrotic area, one can detect atypical cells the actual morphology of which is difficult to determine under low magnification ($\times 55$).
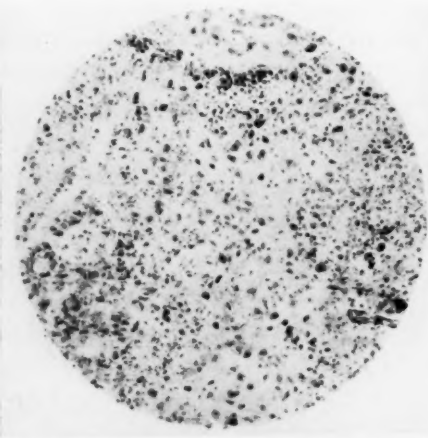
FIG. 2.—Photomicrograph showing a higher magnification of the atypical cells noted in Fig. 1. The cells appeared to be of epithelial origin and possessed unusual mitotic figures. These cells are undoubtedly carcinoma cells. The true nature of these cells was not established at the initial study but was recognized only on reexamination of these sections after the diagnosis of transitional cell carcinoma was made from sections of tissue removed at subsequent operation ($\times 150$).

and palpation resulted in an increased sanguineous discharge from the external meatus. The corpora cavernosa in this area had a hard, indurated consistency, irregular outline and were tender. In the left corpus cavernosum, there was a pea size area which was firmer than the rest. A small irregular firm nodule of tissue was palpable in the spongy urethra about 4 cm. from the external meatus.

FIG. 3.—Photomicrograph showing typical transitional cell carcinoma ($\times 55$).

Attempts to pass a No. 16 olivary bougie beyond the fossa navicularis were unsuccessful. A filiform passed down the urethra for a distance of 4.5 cm. and encountered an impassable obstruction which was not overcome with the aid of several small filiforms. Instrumentation of the urethra was extremely painful. Roentgenograms of the genito-urinary tract including the penis were negative. A tentative diagnosis was made of (1) urethral stricture with cavernositis and peri-urethral abscess, (2) carcinoma of the urethra, and (3) tuberculosis of the urethra.

Course in the Hospital.—Hot compresses were applied to the affected area for ten days resulting in some diminution of the pain and frequency of urination. The patient's general condition had improved so much that on October 4, 1932, an exploration of the affected area was performed under gas. Dense inflammatory adhesions about the urethra were severed and the urethra isolated. A

probe was passed into the urethra from the external meatus and emerged from the urethra at a point where there appeared to be an abscess connecting with the left corpus cavernosum. An incision, 3 cm. long, was made into each corpora and a necrotic cheesy material evacuated. The cavities in each corpora were opened widely and through-and-through drainage with iodoform gauze was established. Some of the necrotic material and tissue from the corpora was sent to the laboratory for histologic study. From the operative findings, it was felt that we were dealing with an abscess of both corpora cavernosa secondary to an urethral stricture.

The pathologic report of necrotic tissue removed from the corpora indicated the
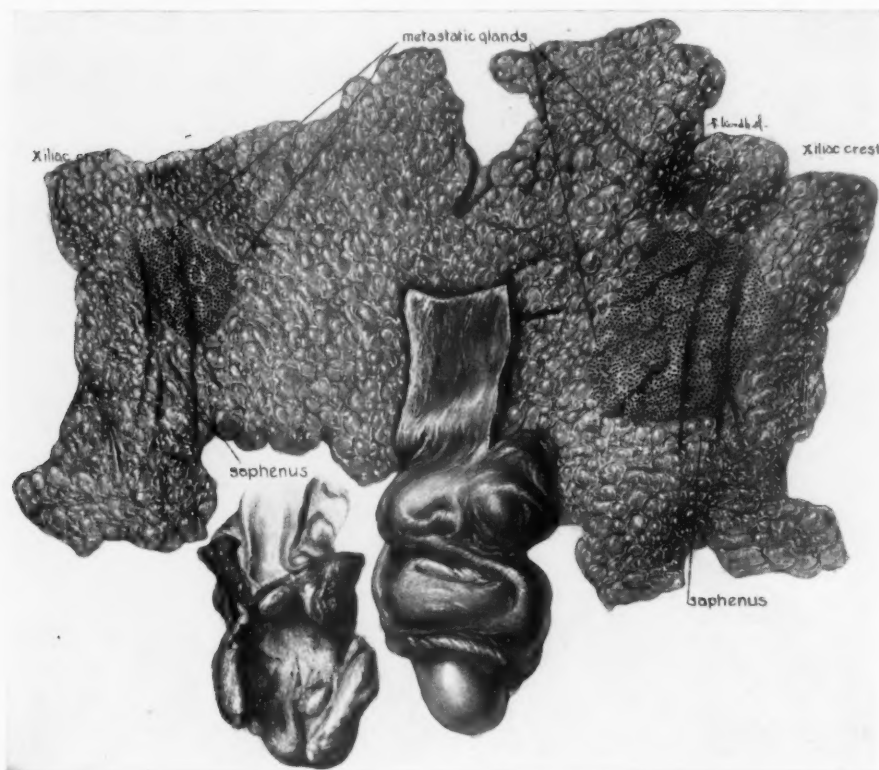

Fig. 4.—Drawing of specimen removed at operation. The dorsal surface of the penis with the flap of skin extending up on to the abdominal area can be readily seen. The shrunken and shriveled appearance of the penis is due to the extensive destructive process and the scars of repeated operations. The subcutaneous tissue of the lower third of the abdomen and the nodes of both inguinal and femoral regions have been removed en masse. The checkered areas indicate the location of groups of necrotic and abscessed nodes in both inguinal areas. The insert shows the ventral surface of the penis. The urethra has been opened to show the marked destruction involving the anterior portion of the penile urethra and both corpora cavernosa. The urethra above the involved area has a normal appearance and is slightly dilated.

presence of chronic inflammatory process with marked tissue destruction (Fig. 1). There were several cellular areas, the actual morphology of which was difficult to ascertain owing to the marked inflammation and necrotic changes. Several of the cells appeared to be of epithelial origin and possessed unusual mitotic figures (Fig. 2). In one section, too poorly stained for photographic reproduction, the cells had a papillomatous arrangement with marked proliferation and regular division. There was a diffuse polymorphonuclear exudate throughout this section. The pathologic diagnosis was infected papilloma of the urethra.

In view of the fact that the patient was having great difficulty in voiding and

showed signs of urinary extravasation about the penile urethra, a suprapubic cystostomy was performed October 28, 1932, under spinal anesthesia in order to divert the urinary stream. The swelling and induration around the spongy urethra and corpora cavernosa persisted. The tissues in this area were necrotic and infiltrated down to the penoscrotal junction. The external meatus was closed off by inflammatory tissue. On November 29, 1932, under gas anesthesia multiple incisions were made in the penis to establish ample drainage and to remove the necrotic tissue. Several pieces of tissue were removed for pathologic study and were reported as a transitional cell epithelioma of the urethra (Fig. 3).

On December 27, 1932, a radical resection of the penis and lymphatic bearing area was performed under spinal anesthesia (Fig. 4) according to the method of Young.
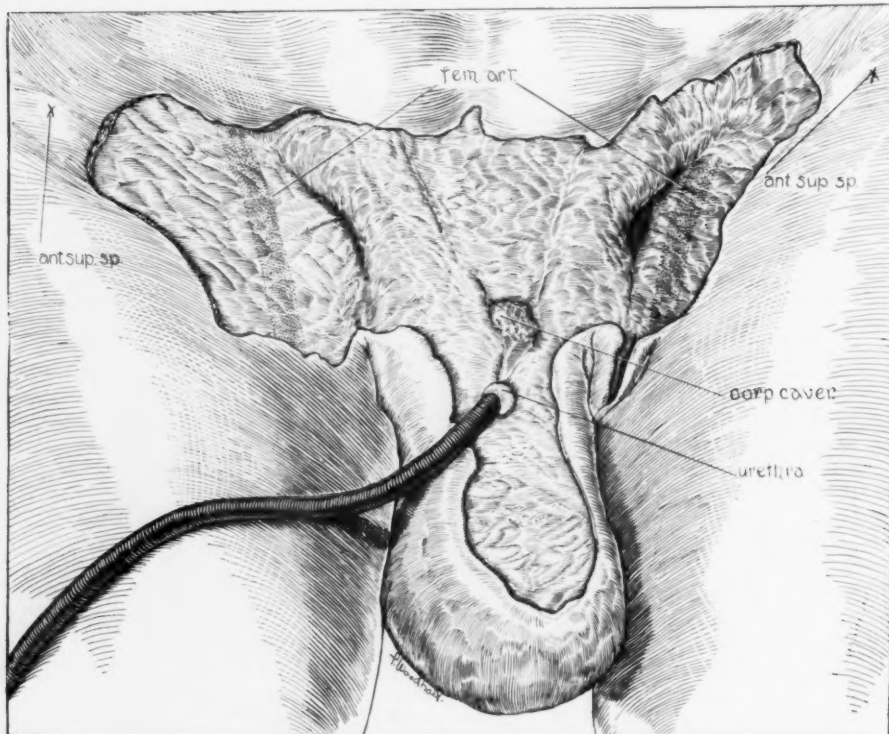
FIG. 5.—Drawing made three weeks after radical operation showing the breaking down of the abdominal portion of the wound and the left inguinal area.

A "bottle" operation was performed on the right side to cure the left hydrocele. The tumor had apparently infiltrated and totally occluded the anterior urethra particularly at the external meatus.

Following this operation, the patient seemed to do well. The remaining corpora, scrotum, right inguinal regions healed per primum. The abdominal area, near the midline, and the left femoral area broke down (Fig. 5). On January 16 and January 25, 1933, pinch grafts taken from the left thigh were applied to the granulating areas with good results. The left inguinal and femoral areas continued to break down and produced a large crater-like sloughing area. This was treated with dry heat, hot compresses, ultraviolet light and roentgen radiation (four treatments—half erythema doses) with little improvement. The patient also developed an abscess in the subcutaneous tissue about the right hip which was incised and drained February 16, 1933.

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The patient appeared to be fairly comfortable for about two months following the radical operation and then became progressively weaker. He developed a terminal bronchopneumonia and died May 17, 1933, which was approximately eight months after admission to the hospital and five months after the radical operation.

Incidence.—The first case of carcinoma of the urethra was reported by Thiaudiere[50] in 1834, but as Kirwin[23] has pointed out, the diagnosis in this case was by no means clearly established. The first authentic case is that of Hutchinson,[21] in 1861. In 1907, Preiswerk[39] gathered 42 cases and in 1928 Kretschmer[24] reviewed the literature from the time of Preiswerk's article and collected 38 additional cases, making a total of 80 cases. In 1932, Kirwin gathered 19 cases from the literature in the nine years elapsing since the appearance of Kretschmer's contribution. The authors have found 12 additional cases, three of which (Tommasoli,[52] 1892; Sequeira,[45] 1905; McCune,[29] 1927) were not included in Kirwin's report and the other nine (Geisler,[14] 1931; Mercier,[31] 1932; Beck,[4] 1932; Sokolov,[47] 1932; Boggon,[5] 1933; Lazarus,[26] 1934; Golonka,[15] 1934; Selvaggi,[43] 1934; and Astraldi,[2] 1935) were reported subsequent to Kirwin's publication, and add one personal case, thus bringing the total to 112 cases.

Kirwin showed that this neoplasm occurs with almost equal frequency in both sexes, or more specifically shows a slightly greater preponderance in the male. He collected 99 cases in the male and 96 cases in the female. Primary carcinoma of the male urethra is seen most frequently in patients past the age of 55 or more particularly in the sixth and seventh decades of life. In several instances, the condition has been observed in patients well under the so called cancer age. Paton's[37] patient was a youth of 18 and was the youngest case reported. Kroiss[25] observed an urethral carcinoma in a man of 91.

There appears to be no racial immunity against epithelioma of the urethra comparable to that existing in relation to epithelioma of the penis. Urethral carcinoma has been reported in a Mohammedan (a Hindoo) by Paton and has been observed in a Jew in the authors' case.

Histopathology.—The normal epithelial lining of the male urethra varies in the different portions of this canal. The distal portion which is limited to the fossa navicularis is lined by squamous epithelium, the cavernous (or penile) portion by columnar epithelium and the prostatic urethra by transitional epithelium. In view of the variations in normal cellular morphology of the urethral mucosa, one may expect to find different cellular types of carcinoma. The histopathology of urethral carcinoma discloses three major types: namely, squamous cell epithelioma, papillary carcinoma, and a columnar cell variety of carcinoma. The most common type encountered is the squamous cell carcinoma with typical pearly body keratinization. This lesion occurred in 66 of Kretschmer's series of 80 cases.

Papillary carcinoma, as described by Shattock,[46] Englisch,[12] Kretschmer, and the columnar cell variety as described by Cabot[7] occur less frequently. Other rare types of urethral carcinoma are the transitional cell carcinoma

reported by Robb[41] and the adenocarcinoma reported by Olivier and Clunet[35] and Romano.[42] Geisler[14] described a case of "very unripe medullary" carcinoma which was extremely difficult to differentiate from sarcoma. Robb[41] analyzed the histopathologic data in 76 cases collected from the literature and found that squamous cell carcinoma occurred in 73 per cent, adenocarcinoma (from Cowper's glands) 21.2 per cent, papillary carcinoma 3.5 per cent, columnar cell carcinoma 1.5 per cent, and transitional cell carcinoma 1.3 per cent.

Location.—A survey of the literature reveals the fact that any portion of the urethra may be the site of the carcinoma although certain portions show a greater predilection than others. For clinical and pathologic purposes, it seems more practical to divide the urethra into two sections: (a) penile, which includes the fossa navicularis and the cavernous portion, and (b) perineal, which consists of the bulbomembranous and prostatic portions and is frequently referred to as the deep urethra. The importance of this classification lies not in the type of tumor concerned but rather in the practical adaptability of this classification to the course, extension, diagnosis and treatment of a tumor situated in either portion.

Carcinoma occurs more frequently in the perineal than in the penile urethra inasmuch as the majority of the primary urethral neoplasms are situated in the bulbomembranous portion. Preiswerk[39] found the cavernous and membranous areas were involved in 38 of 42 collected cases. Rizzi[40] noted that the cavernous urethra was involved in 52 per cent, the bulbous portion in 25 per cent, and the prostatic portion in 22 per cent. In Diehl's[10] series of 61 cases, the distribution was as follows: fossa navicularis, two cases; cavernous urethra, 26 cases; and membranous urethra, 33 cases. Legueu[27] states that 63 per cent of urethral neoplasms are found in the perineal portion. In the cases described by Menard,[32] Deveze,[9] Rizzi,[40] Olivier and Clunet,[35] Tixon[51] and Kirwin,[23] the growth was seen protruding from the external meatus.

Pathology.—In its early stage, urethral carcinoma may present itself as a well localized growth which later manifests a tendency to spread slowly and insidiously and involve the adjacent urethral tissues. In those cases where the tumor is situated in the fossa navicularis or in anterior portion of the penile urethra, the growth may appear at the external meatus and, on rare occasions, may involve the glans penis. When the growth is located in the deeper portion of the penile urethra or in the bulbomembranous portion, the tumor may exhibit a tendency to spread and involve the remainder of the penile urethra as occurred in the authors' case but seldom appears to extend beyond the triangular ligament and invade the prostate. Tumors occurring in the perineal or deep urethra may extend laterally and posteriorly to invade the perineum, triangular ligament, prostate or bladder. Invasion of the corpora cavernosa takes place relatively early and produces a friable necrotic mass which soon becomes secondarily infected. The malignant process may extend further and involve the skin of the penis or perineum with the formation of single or

multiple fistula and if infection supervenes, a periurethral abscess. The scrotal tissue and contents are seldom involved by the neoplastic process.

It is characteristic of urethral carcinoma to produce an obstruction of the urethral lumen either by circumferential constriction or by pedunculated masses. In some cases the partial or complete obstruction produced by the neoplasm is sufficient in itself to cause a rupture or tear in the urethral tissue which is followed by an extravasation of urine and eventually suppuration. The likelihood of urinary extravasation and infection of the peri-urethral tissues occurring is increased when the obstruction by the tumor is added to that produced by a preexisting stricture. The urinary extravasation usually occurs at or above the point where the friable and necrotic tumor tissue involves the urethra and produces the greatest obstruction. Since the urine in all patients with urethral carcinoma is infected with one or more different types of pathogenic bacteria, frank suppuration follows the extravasation and results in the appearance of an abscess in the corpora, periurethral tissues or perineum. Fistula formation is fairly common and may or may not be associated with urinary extravasation. In those cases where the tumor is located in the penile urethra, the opening of the fistula or fistulae is generally found on the under surface of the penis but may be found on any surface. In the case reported by Legueu, the opening was on the dorsum of the penis. When the tumor is situated in the perineal urethra and a fistula develops its opening is found in the perineum. The fact that these fistulae may form before the correct diagnosis is established is responsible for the doubt that exists in regard to whether the tumor is primary in the urethra or is the result of the malignant degeneration of the epithelial lining of the fistulous tract.

Metastases.—Regional metastases by way of the lymphatics occur relatively late in the course of the disease and involve the inguinal or iliac nodes or both. Metastasis to the inguinal nodes occurs in practically every case and their involvement can usually be detected by careful palpation at the time of the initial examination. Selvaggi[43] calls attention to the fact that the inguinal adenopathy is often inflammatory. Metastatic involvement of the pelvic and lumbar nodes may occur as in the case reported by Montgomery[33] in which no other metastases were found at necropsy.

Metastases may involve structures or organs other than the inguinal and iliac nodes and reach these distant organs by a hematogenous route. In Allenbach's[1] case, the tumor not only metastasized to the iliac nodes about the left ureter but also to the lungs and liver. Metastatic nodules were found in the lungs of Guiard's[17] patient. Geisler[14] reported a case of medullary carcinoma of the polypoid type which was primary at the junction of the prostatic and membranous urethra and showed metastatic growths in the fossa navicularis, left epididymis and perineum.

Etiology.—In a review of the cases reported, one is immediately impressed with the possible etiologic relationship between urethral carcinoma and other preexisting or coexisting diseased conditions. The following conditions bear

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consideration as predisposing factors in the development of urethral carcinoma: (a) gonorrhea and its complications; (b) nonspecific urethritis; (c) papilloma or polypi formation; (d) leukoplakia; (e) trauma or irritation of a mechanical or chemical nature; (f) sex perversion; (g) sexual contact and (h) Paget's disease of the penis.

(a) The frequency with which a history of gonorrheal stricture is associated with urethral carcinoma further emphasizes this causal relationship. Beck[3, 4] attached much significance to this relationship and concluded that urethral carcinoma was a disease occurring in men past the age of 50 who have had a gonorrheal stricture. In Tanton's[49] series of 65 cases, 26 had had gonorrhea.

O'Neil[36] maintained that stricture was present in more than 50 per cent of the cases and Kirwin is of the opinion that there is a previous history of stricture in at least two-thirds of the cases. On the other hand, Kretschmer maintained that stricture should be regarded as an etiologic factor only so far as it might produce metaplasia or leukoplakia of the urethral mucosa. Imbert[22] has pointed out that the rarity of urethral cancer in the females is due to the fact that though gonorrhea frequently affects females, it is not so common with them as with men and that a gonorrheal stricture is an unusual finding in females. However, it is well to bear in mind that a large percentage of the cases give no history of gonorrhea or stricture formation and that a mere history of a gonorrheal infection, unsupported by an actual proof of the presence of a stricture, by no means establishes an immediate or direct etiologic relationship between gonorrheal urethritis and the carcinoma. It should be further emphasized that while urethral stricture following gonorrheal urethritis is common, malignant disease is rare. Robb reported a case of urethral carcinoma which had undoubtedly originated in a gonorrheal stricture. This patient also received 477 instrumentations during a series of 111 visits over a period of six years. This case emphasizes the rôle of chronic irritation from instruments in the production of urethral carcinoma in stricture cases. Wasserman, Gayet,[13] Platt and others have stressed the origin of carcinoma in the area of dilatation behind the stricture rather than in the stricture *per se*.

(b) A chronic urethritis of a nonspecific nature may likewise be responsible for producing an irritation or injury to the urethral tissues conducive to the development of a neoplasm. Scholl, Braasch and Long[44] reported a case in which the patient had an infectious urethritis in his youth with subsequent stricture formation which required dilatation over a period of 20 years. Guyon[18] described a case of urethral carcinoma in a patient who had suffered from a chronic urethritis with multiple perineal fistulae over a period of ten years. In some cases the urethral neoplasm has been found to be engrafted upon the site of a peri-urethral abscess.

(c) In some cases, a benign papilloma had been previously removed as noted in the cases reported by Grunfeld[16] and Kretschmer. In such cases the papilloma is usually in the anterior urethra close to the external meatus.

(d) A history of an antecedent leukoplakia has been mentioned in several cases. The authors have observed one case of leukoplakia of the anterior urethra in which carcinoma was suspected but a positive diagnosis could not be made as the patient refused operation.

(e) The rôle of trauma in the development of the urethral neoplasm has been strongly emphasized by several authors and by many is considered next in importance to gonorrhea and stricture formation as a predisposing factor. The type of injury may be classified as instrumental, accidental or chemical. Trauma of an accidental nature antedating an urethral carcinoma has been reported too frequently to be considered a mere incidental finding. Rizzi found a history of trauma in 10 per cent of the cases. In the cases reported by Bierberbach and Peters,[6] Young,[55] Lower[28] and Hutchinson,[21] an injury to the perineum antedated the urethral neoplasm. Trauma in the form of chemical irritation as reported by Shattock,[46] Kretschmer and Culver[8] has been infrequently observed.

(f) Sex perversions may be another possible factor as indicated by the reports by Soubeyran[48] and of Olivier and Clunet. The introduction of foreign bodies into the urethra for masturbation purposes may result in injury to the urethral tissues as occurred in Soubeyran's patient who habitually inserted straws into the urethra.

(g) The rôle of sexual contact in the transmission of genital carcinoma in both sexes has not been definitely established. Edelman[11] has reported two cases of alleged contact infection from women with genital carcinoma.

(h) There are two cases (Tommasoli[52] and Sequeira[45]) in literature, not included in any previous report, in which a carcinoma of the urethra developed after a Paget's disease (malignant papillary dermatitis) of the penis.

Symptomatology.—There is no symptom complex typical of carcinoma of the male urethra and for this reason the diagnosis is seldom made in the early stage. In an analysis of the symptomatology of the cases reported in the literature, one is impressed with the fact that in the majority of the cases the patient states that he has enjoyed good health until the symptoms of urethral obstruction manifest themselves. The chief complaint and predominating symptom in practically every case is difficulty in urination which is strongly suggestive of the presence of a stricture or obstruction. The urinary difficulties resulting from obstruction may last for several months before local tumor formation is manifested or infection supervenes. Marked tenesmus and ardor urinae accompany the act of urination.

As the condition progresses, the pathologic process in the urethra spreads and produces changes in the size, shape and consistency of the penis. The presence of the development of a tumor mass is frequently the first sign that draws the attention of the physician or patient to the existence of a more serious lesion than a stricture. The penis swells in size and may assume a red hue or even appear to be cyanotic. A bloody cyst may develop on the under surface of the penis. Careful inspection and palpation will reveal one or more nodules along the course of the urethra or in the corpora.

Edema may be present over the penis, scrotum and perineum and may be so severe as to simulate an extravasation of urine. The spread of the tumor into the erectile tissue of the corpora cavernosa may lead to a permanent partial erection or even to complete priapism. The narrowing or occlusion of the urethral lumen and the involvement of the corpora resulting from the spread of the tumor is responsible for erections and ejaculations becoming more and more painful until coitus becomes impossible.

Infection may supervene before the tumor becomes noticeable and as a result an urethral discharge may appear, which, if it has not been present or evident before, should direct attention to the possibility of an unrecognized lesion. The presence of a discharge may be one of the first signs to attract the patient's attention to his local condition. The discharge may contain gonococci as in the case reported by O'Neil, or it may be bloody as in Rizzi's and the authors' cases.

However, since the signs and symptoms of urethral carcinoma vary with the location of the tumor, it would appear more practical to consider the symptomatology as applied to the commonly accepted classification of this tumor into the following types: (a) penile, and (b) perineal. A brief consideration of the principal symptoms attending each of these two types is in order:

(a) Penile Tumor.—The outstanding symptoms of this type of tumor are (1) urinary difficulties resulting from obstruction, (2) the presence of a palpable tumor mass, and (3) urethral discharge and urethral bleeding. Pain erections and priapism may be present.

(b) Perineal Tumor.—In this form, as in the penile type, symptoms of obstruction are present but are not quite so prominent. The most striking feature is the frequency of signs and symptoms of an infection superimposed upon those of obstruction. The most common finding is a peri-urethral abscess which serves as a successful disguise for the tumor. Urinary infiltration and extravasation are common findings. The final picture is one of fistula formation. Urethral bleeding, priapism, pain and urethral discharge are less frequently noted.

Diagnosis.—The diagnosis of carcinoma of the urethra can be made with comparative ease when the tumor is situated in the penile urethra, especially those occurring in the fossa navicularis. Tumors situated in the perineal urethra offer the greatest diagnostic difficulties. We cannot urge too strongly the employment of early, and if necessary, repeated urethroscopic examination in all obscure cases of urinary disorders involving the lower urinary tract in which cystoscopy has failed to reveal the exact cause. This useful diagnostic procedure should not be postponed until a palpable tumor presents itself when it only serves to confirm the suspicions of the surgeon.

Mark[30] in 1908 and Imbert[22] in 1921 could find only three authentic cases in the literature where the carcinoma of the urethra was recognized by urethroscopy, *viz.,* Grunfeld,[16] 1885; Beck,[3] 1890; and Oberlander,[34] 1893. However, in the recent literature, urethroscopy has been frequently employed by

many observers as a means of establishing or confirming the diagnosis. A piece of tumor should be removed through the urethroscope for microscopic examination in every case, if possible.

Differential Diagnosis.—As noted above, there should be no difficulty in establishing a correct diagnosis in those cases where the neoplasm is situated in the anterior or penile portion of the urethra because of the readiness with which a piece of the tumor can be removed for microscopic examination. Urethral neoplasms, particularly those situated in the perineal urethra, must be differentiated from the following conditions: (1) stricture; (2) peri-urethral abscess; (3) intra-urethral chancre; (4) tuberculosis; (5) carcinoma of the prostate; (6) carcinoma of Cowper's glands; and (7) benign tumors of the urethra.

The greatest diagnostic difficulties are encountered in differentiating urethral carcinoma from stricture. There are several diagnostic signs which are more characteristic of carcinoma than of stricture; namely, the occurrence of bleeding not associated with urination or erection, the presence of enlarged inguinal nodes of a metastatic nature, pain in the penis unassociated with urination, and loss of weight. A positive diagnosis can be made by urethroscopic examination and biopsy in cases of urethral neoplasm.

Prognosis.—The prognosis in cases of urethral carcinoma is dependent upon the site of the lesion, the duration of the growth, and the extent of the metastases. In those cases where the neoplasm is situated in the anterior urethra near the external meatus and can be diagnosed early and is easily accessible to the necessary conservative or radical treatment, the prognosis is uniformly good. The prognosis is usually poor in cases of carcinoma of the perineal urethra where the tumor has spread extensively and infiltrated the surrounding tissue so that by the time the diagnosis is made operative treatment is impractical. The outlook is decidedly better in cases where the carcinoma is confined to the penile urethra as this type of case is amenable to operative treatment and has yielded the greatest percentage of cures. The occurrence or development of such complications as localized infections or abscess formation, extravasation, fistula and upper urinary tract disease which are secondary to the urethral obstruction naturally militate against a good result in these cases. Death in the operative or nonoperative case has usually been due to urosepsis.

Treatment.—The surgical treatment of urethral carcinoma has been far from satisfactory judging from the results reported in the early and even the recent articles on the subject which may be attributed to the fact that surgical intervention was employed too frequently in cases with hopeless infiltration and extensive infection. In many instances, the operation was undertaken primarily for symptomatic relief which is borne out by the fact that 79 per cent of the 72 cases collected by Watson[54] in 1929 were dead within six months after operation.

Radical operation is the procedure of choice in the treatment of urethral carcinoma and offers the best results from a curative standpoint. In view

of the fact that metastases occur late in the course of the disease, radical operation should be employed in every case excepting those advanced cases with severe infections and hopeless infiltration and metastases.

We feel that it is best to remove the inguinal node bearing area in every case and thus prevent the possibility of a recurrence of the tumor in these nodes and at the same time remove every bit of potentially malignant tissue. In the very advanced cases with extensive lymph node metastases beyond the groin, radical operation is not indicated especially if the patient is in poor condition. In such cases, the operative treatment should be limited to simple amputation of the penis to remove the necrotic and infected tumor mass and to incision and drainage of abscess areas when present.

For those cases in which the tumor is confined to the anterior portion of the penile urethra and the surgeon is desirous of removing the affected organ together with the inguinal nodes, Young's operation (as described for carcinoma of the penis) appears to be the ideal procedure. In those cases where the tumor is situated in the distal third of the penile urethra or in the bulbomembranous portion of the perineal urethra, the operative removal of the entire penis including both corpora and practically the entire corpus spongiosum can best be performed by utilizing two incisions as described by Huggins and Curtis.[20]

Emasculation in cases of urethral carcinoma appears to be both unnecessary and undesirable as the malignant process seldom involves the scrotum or testes. Such mutilation adds immensely to the unhappiness of the patient as well as to his discomfort. Tumors confined to the anterior portion of the penile urethra and appearing at the external meatus can be treated by more conservative measures than radical operation. Electrocoagulation of the tumor area supplemented by the application of radium should give good results providing such treatment is instituted early before involvement of the inguinal lymph nodes has occurred. Kirwin reported a case in which the original lesion, situated close to the external meatus, was excised with bipolar cautery.

Herbst[19] in 1925 reported a case successfully treated by radium when fulguration failed to give results. However, the consensus of opinion is that in the late cases radium and deep roentgen therapy are of little value. Bierberbach and Peters[6] found that radium hastens necrosis of the malignant tissue producing a fatal toxemia and terminating life. Postoperative radiation of the perineum and inguinal node bearing area is indicated in those cases where the lymph nodes were not removed.

Scholl, Braasch and Long reported a case of urethral carcinoma in which the membranous urethra was excised through the perineum and later a portion of the saphenous vein was transplanted to fill in the defect. The patient also received 250 mg. of radium in the tumor area and was reported alive and well four and one-half years later.

In 1929 Watson[54] reported two cases of urethral carcinoma treated successfully by radium therapy. In two of the three cases reported by Lower,[28]

a local resection of the urethra was performed with an end-to-end anastomosis and in both of these cases, stricture followed. There was no recurrence after eight years in one case and nine years in the others. The third case was an adenocarcinoma of the bulbomembranous urethra with extensive involvement of the urethra and metastases in the inguinal nodes. A radical operation was performed and the patient was reported free of recurrence at the end of two and one-half years. Kretschmer also reported a case in which there was no recurrence two years after radical operation.

CONCLUSIONS

(1) The authors report a case of carcinoma of the male urethra in a Jew and have collected 12 additional cases from the literature, thus making a total of 112 cases reported to date.

(2) Primary carcinoma of the male urethra occurs most frequently in patients past the age of 55, particularly in the sixth and seventh decades of life.

(3) There appears to be no racial or climatic immunity against carcinoma of the urethra comparable to that existing in relation to epithelioma of the penis inasmuch as cases of urethral carcinoma have been observed in Jews and Mohammedans and have been reported from all parts of the world.

(4) The three major types of urethral carcinoma are squamous cell epithelioma, papillary carcinoma and a columnar cell variety of carcinoma. Other less frequent forms are the transitional cell carcinoma, adenocarcinoma and medullary carcinoma. The most common type is the squamous cell carcinoma which occurs in more than 50 per cent of the cases.

(5) Primary carcinoma may occur in any portion of the urethra but is seen most frequently in the perineal urethra (bulbomembranous portion) than in the penile urethra.

(6) Primary urethral carcinoma may present itself as a well localized growth in the early stage and later manifest a tendency to spread slowly and involve the adjacent urethral and periurethral tissues with subsequent infection and development of a stricture, abscess, fistula or extravasation.

(7) Regional metastases by way of the lymphatics, involving the inguinal nodes particularly and less frequently the iliac nodes, are present in practically every case and occur relatively late in the course of the disease.

(8) There is no symptom complex absolutely typical of urethral carcinoma due to the fact that the symptoms vary with location of the growth and are noticeably affected by the presence of such complications as stricture, extravasation, abscess or fistula.

(9) Urethroscopic examination is the ideal method of establishing an early and correct diagnosis. A piece of tumor should be removed through the urethroscope for microscopic examination in every case if possible.

(10) The prognosis is dependent upon the duration of the growth, its location and the extent of metastases. Death in the operative or nonoperative case is usually due to urosepsis.

(11) Surgical treatment offers the greatest chance for a cure. Radical operation should be employed in every case excepting (a) in those advanced cases with severe infections, hopeless infiltration or metastases; and (b) in those cases with tumors confined to the anterior portion of the penile urethra, especially at the external meatus which may be treated by more conservative methods, *i.e.,* electrocoagulation, and by radium.

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SEVERED TENDONS AND NERVES OF THE HAND AND FOREARM

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Two HUNDRED NINETY severed tendons and 26 severed nerves of the wrist and hand were treated by the Second Surgical Division of St. Vincent's Hospital during the ten year period 1924 to 1934, on the service of the late Dr. George David Stewart and his successor, Dr. Raymond P. Sullivan. The severed tendons occurred in 102 patients, while the severed nerves were found in 22 patients, 11 of them having both tendons and nerves severed. In all there were 113 patients injured.

The salient facts derived from this analysis of injuries to the upper extremity are as follows: That the nature of the weapon inflicting the injury bears a predisposing influence on both the site and the severity of the laceration; that infections in the wounds are not uncommon and may have serious sequelae; that these injuries occur usually in males and rarely in females; that there is no predilection for either arm to be involved, and that the section of the city within which the injury occurs bears a direct influence on the type of the weapons or implements causing the trauma.

Causes.—The type of the weapon inflicting the injury has, by its very nature, an influence on the exact site, the severity and the ultimate outcome of the injury. The nature of the weapons varied in different sections of the

TABLE I

NATURE OF AGENT CAUSING INJURY

Dorsum of Hand and Fingers.	16 of 33 Known Causes Were Compensation Injuries 10 Cases from Broken Glasses or Bottles 4 ″ ″ Breaking Windows
Palm of Hand and Fingers....	20 of 35 Known Causes Due to Broken Glass (16 Broken Bottles and Glasses—4 Breaking Windows) 6 Cases Due to Compensation Injuries
Volar Surface of Wrist.......	22 of 29 Causes Due to Broken Glass (16 Broken Windows—6 Broken Bottles or Glasses) 5 Cases Due to Compensation Injuries (Caused by Falling Glass or Steel)
Dorsal Surface of Wrist......	The 2 Known Causes were Stabbings

27 of 99 known causes were due to compensation injuries.
6.8% of cases resulted from stabbings (St. Vincent's Hospital).
At Harlem Hospital the percentage is about 80–90%.

city (Table I), depending on the character of the industry and the racial traits of the inhabitants within a hospital's territory.

At St. Vincent's Hospital, situated in the Greenwich Village section of the city and serving a large industrial and commercial area, the most frequent tendon trauma (54 per cent) is inflicted by broken glass from windows, bottles and drinking vessels, while the next most frequent cause is compensation injuries (29 per cent), inflicted by printing presses, circular saws and other forms of factory machinery. The third cause, in order of frequency at this hospital, and comprising less than 7 per cent of the known causes, is stab wounds. In contrast to this last percentage in this section of the city, we have that of Harlem Hospital, where 80 to 90 per cent of all tendon lacerations are the result of stabbings.

Stab wounds are rarely inflicted on the palm of the hand, as the defendant is usually loth to grasp the sharp blade of the weapon that is thrust at him but instead endeavors to bat the blade away with his forearm. As a result about 75 per cent of these wounds are found at the wrist or on the dorsum of the hand (Table II).

TABLE II

LOCATION OF INJURIES

Weapons	Volar Surface Wrist	Dorsal Surface Wrist	Palm Hand and Fingers	Dorsum Hand and Fingers
Glass (52 Cases)				
24 Windows.....	16	0	4	4
28 Glass Bottles.	6	0	16	10
Stab Wounds				
(7 Cases).......	1	2	2	2
Suicide Attempt				
(1 Case)........	1 Razor	0	0	0
Miscellaneous Accidents (8 Cases)	0	0	7 { 1 Electric Fan 1 Organ Fan 1 Faucet 1 Razor 3 Knives	1 Playing Baseball
Compensative Injuries (27 Cases)	4 Falling Glass or Steel 1 Machine (3 left 2 right)	0	6 { 3 Saws 1 Press 1 Knife 1 Sheet Iron (3 left 3 right)	16 { 5 Machines 2 Saws 2 Gears 2 Presses 1 Knife 4 Falls on Glass or Can (8 left 8 right)
Totals (All Causes Not Reported)..	29	2	35	33

Compensation injuries occur most frequently on the dorsum of the hand. These injuries are frequently jagged or crushing wounds which cause considerable maceration of tissue and are difficult to repair.

Broken windows usually severed the tendons at the level of the wrist, while broken bottles and glasses usually traumatized the tendons in the palm of the hand and fingers.

Numerous miscellaneous accidental causes were recorded, such as those caused by porcelain faucets, electric fans, organ fans, razors and kitchen knives, as well as one suicide attempt.

Side and Sex Incidence and Site of Laceration.—Injuries were equally distributed between both limbs. Ninety-five of the 102 patients with tendon injuries were males (Table III). All injuries to females were slight. In-

TABLE III

SEX AND SIDE INCIDENCE

		Right Hand...................... 49
	95 Males	Left Hand......................... 47
		1 Case Bilateral
Tendons (102 Cases)		
		Right Hand...................... 2
	7 Females	Left Hand......................... 5
		(All Slight Injuries—No Severe Wounds.)

Neither compensations injuries, broken glass nor broken windows had a predisposition to injure any one side of the body.

juries at the wrist usually involved four or more tendons and one out of every two of these lacerations severed one or more nerves (Table IV).

TABLE IV

SITE OF 109 WOUNDS IN 102 CASES OF TENDON LACERATION

Flexor surface............................. 77   (70.7%)
Extensor surface........................... 32   (29.3%)

32%	of all lacerations were at the wrist
68%	" " " " in hand or fingers
17.5%	" " " " " the hand
50.5%	" " " " " " fingers

40%	of all flexor lacerations were at the wrist
60%	" " " " " in hand or fingers
15.5%	" " " " " " the palm of hand
44.5%	" " " " " " " digits (palm)

12.5%	of all extensor lacerations were at the wrist
87.5%	" " " " " in the hand or fingers
21.8%	" " " " " on the dorsum of the hand
65.7%	" " " " " in the fingers (dorsum)

Fifty per cent of the lacerations were in the fingers and 32 per cent at the wrist, 71 per cent were on the flexor surface and 29 per cent were on the extensor surface. Our records show a preponderance of the injuries occur-

ring in three definite sites: In their order of frequency they are (1) the palmar surface of the proximal phalanges, (2) the volar aspect of the wrist, and (3) the palm of the hand. Two hundred twenty-two were digital tendons and 68 wrist tendons (Table V and Fig. 1).

TABLE V

SITE OF 109 LACERATIONS IN 102 CASES OF TENDON INJURY

	Flexor Surface			Extensor Surface			Totals		
	Right	Left	Total	Right	Left	Total	Right	Left	Total
Wrist...........	14	17	31	3	1	4	17	18	35
Hand...........	6	6	12	3	4	7	9	10	19
Digit I.........	5	4	9	2	3	5	7	7	14
Digit II........	1	5	6	5	1	6	6	6	12
Digit III........	5	5	10	1	3	4	6	8	14
Digit IV........	2	3	5	2	2	4	4	5	9
Digit V.........	3	1	4	0	2	2	3	3	6
Totals........	36	41	77	16	16	32	52	57	109

Time of Repair.—Every effort should be made to see and repair these cases at the earliest possible moment, for a primary repair is of great economic value to the patient, and the ultimate functional result following a
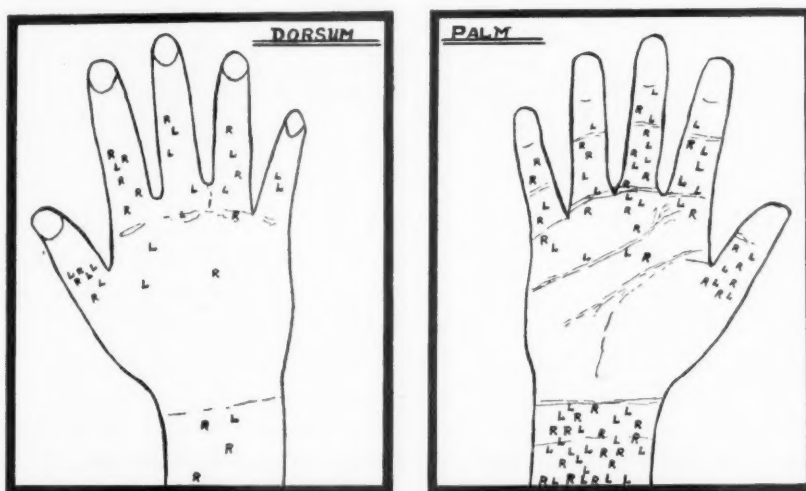
FIG. 1.—Graphic representation of site of injury in cases of tendon laceration. R indicates right hand. L indicates left hand.

primary repair is far better than after a long delayed secondary repair has permitted the occurrence of atrophy and scar tissue formation.

It is now an accepted practice and rule not to operate for primary repair of tendon injury unless the patient could be brought to the operating room within a certain limited number of hours as measured from the time the trauma was inflicted. Injuries to the palm of the hand and palmar surface of the digits, all of which are supplied with tendon sheaths, must be repaired before two to three hours have elapsed. Injuries to the volar surface of the

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wrist must not be sutured any later than four hours after injury. Deep lacerations of the dorsum of the wrist must be operated upon within six hours, while a somewhat longer period of time may be allowed to elapse before repairing severed tendons on the dorsum of the hand and fingers where there are no true tendon sheaths. However, recently the policy of some has become even more conservative, and it is advocated by some never to do a primary repair of the flexor tendons of the palm of the hand but to wait

TABLE VI
ANALYSIS OF 290 SEVERED TENDONS

222	Were Severed	Digital Tendons	76.5%		
68	"	" Wrist "	23.5%		
158	"	" Digital Flexors	54.5%	44.4% (Right)	55.6% (Left)
64	"	" Digital Extensors	22%	51.5% (Right)	48.5% (Left)
135	"	" Tendons in Right Limb	46.6%		
155	"	" " " Left "	53.4%		

	Flexors			Extensors			Totals		
	Right	Left	Total	Right	Left	Total	Right	Left	Total
Wrist..........	28	30	58	4	6	10	32	36	68
Digit I.........	7	9	16	6	10	16	13	19	32
Digit II........	9	27	36	14	7	21	23	34	57
Digit III.......	19	25	44	4	6	10	23	31	54
Digit IV.......	15	15	30	5	4	9	20	19	39
Digit V.........	20	12	32	4	4	8	24	16	40
Totals........	98	118	216	37	37	74	135	155	290
Digital Tendons.	70	88	158	33	31	64	103	119	222

and do only secondary repairs. To this extreme policy we do not subscribe because of the protraction of the disability, which, in our opinion, is unwarranted if the necessary precautions are taken to prevent infection when performing a primary repair.

Operations.—Twelve cases were not operated upon for various reasons, and 12 had secondary repairs, while 78 had primary repairs, thus leaving a net total of 265 tendons which were repaired at 90 operations (Table VII).

TABLE VII
OPERATIONS FOR TENORRHAPHY

Total Cases....................	102	Total Tendons...................	290
Cases Not Repaired.............	12	Tendons Not Repaired...........	25
Cases Repaired.................	90	Tendons Repaired...............	265

199 Flexor and 66 Extensor Tendons Sutured

Primary Repair in................................... 78 Cases
Secondary Repair in............................... 12 Cases
12 Cases Infected..................................... 13⅓% Percentage of Infection

No Deaths

The number of tendons repaired at any one operation varied between one and 14, depending on the site and severity of the laceration. The more extensive injuries often try the patience of the surgeon, as in a few instances they necessitated almost four hours to accomplish a meticulous repair of the damage done.

Incidence of Infections.—Infection is the greatest danger associated with tendon injury, and if the surgeon does not believe he can thoroughly disinfect the wound and prevent the dissemination of the bacteria into the fertile soil of the surrounding soft parts while exploring the tissues for the retracted ends of the tendons, and unless he has seen the case sufficiently early, he should not attempt to perform a primary repair. These cases should never be drained, for if drainage is necessary the attempt at repair should not be made. The insertion of drains will jeopardize the functional result and will mitigate against that which is most desired; namely, the healing of the wound by primary intention. If the danger of infection is great, then the wound should be allowed to heal and no attempt at a secondary repair should be attempted for at least four to six months. The danger of virulent bacteria lying dormant in the soft tissues is as true in this type of case as it is in the open bone reduction after a compound fracture, when no surgeon would attempt the correction of the deformity for at least six months after the compounding wound was entirely healed.

Analysis of the 90 cases which were repaired showed that 12 cases became infected subsequently, thus creating a rate of infection of 13.33 per cent. In seeking after the cause or causes of this complication, every phase of the situation was investigated and it was found that seven of the 12 infected wounds were inflicted at, or immediately above, the flexor surface of the wrist, that three were on the flexor surface of the middle or proximal phalanges and two were on the dorsum of the hand, thus showing a marked tendency for the flexor tendons, especially at the wrist. The wounds in two patients were the result of stabbings, one man was injured at a machine, eight were incapacitated by broken glass or windows. The suture material in 11 of the 12 cases was chromic catgut and in the remaining case black silk was used. To emphasize further the disaster of infection in this type of case, it is significant to note that five of the seven known poor end-results in this whole series of cases were infected (Table VIII). The devastating effect of infections in wounds of sutured tendons is the death of the tendon due to the impaired blood supply and its subsequent sloughing out, leaving that part of the limb, which it had mobilized, completely incapacitated. Extensive infections about the wrist and palm of the hand may destroy all the tendons and cause the patient to be afflicted for the remainder of his life with a claw hand.

Tendon surgery has been too lightly regarded by many surgeons in the past. The custom of discharging a patient from the ward within a few days after operation is unfortunate, for on several occasions although the wound

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was apparently clean on discharge from the ward, the patient returned to the Outpatient Department with a suppurating wound.

<div align="center">TABLE VIII</div>

<div align="center">INCIDENCE OF INFECTIONS</div>

12 Infections in 90 Primary Repair Operations.............................. 13⅓%
11   ”   ” 79 Repaired with Chromic Catgut......................... 14%
 1 Infection in 11   ”   ” Black Silk.............................. 9%

22½% Infections in Wound of Volar Aspect of Wrist...................... (7 of 31)
28½%   ”   ”   ”   ” Dorsum of Hand............................ (2 of 7)
 8⅘%   ”   ”   ”   ” Palm of Hand and Fingers (Area of the Bursae).. (3 of 34)

Cause: 8 Broken Glass or Windows, 2 Stabbings, 1 Machine, 1 Unknown.
End-Results: 5 of 6 known results were poor and 1 good. 2 developed claw hands.

Surgical Repair of Severed Tendons.—In repairing severed nerves and tendons great care, perfect surgical technic and excellent surgical judgment are required. As regards the surgical procedure and technic, there is no need to elaborate at length but it would be well to stress a few important points.

(1) On admission the wound should be treated with an antiseptic and a sterile dressing applied. A temporary splint should then be fitted so as to hold the hand in a corrected position, with the injured tendons relaxed.

(2) Scrub the adjacent skin with soap and water. This is usually best done after the patient is anesthetized. Take care not to wash any further contamination into the wound. The washing of the skin should be done by the surgeon himself. If danger of additional contamination of the wound exists, it is more expedient to omit any scrubbing of the skin than to chance additional infection. Asepsis is all important.

(3) Paint the skin with iodine, picric acid or any other suitable disinfectant and swab the open wound with the same solution or 70 per cent alcohol. Swab the wound several times during the operation with iodine. I have made it a practice to pour a cup of iodine into the wound, and to this I attribute the absence of a single infection in any of my personal cases.

(4) A débridement of all the skin edges should be done.

(5) Do not crush your skin edges, as primary healing is desired.

(6) A tourniquet (or blood pressure cuff) may or may not be used. Some surgeons strongly advocate the bloodless field for nerve and tendon repair but the danger of a secondary ooze or hematoma must be considered. Personally I prefer to operate without the use of a tourniquet, and it is my opinion that its use predisposes to the death of much of the already traumatized tissue, whose blood supply has been impaired by the original trauma.

(7) Handle all structures, especially the nerve ends, with the greatest of gentleness. Do not crush the tendon ends with Allis clamps and do not use any sharp instrument in handling a nerve.

(8) Avoid, if possible, cutting across the normal flexion creases of the skin of the digits. Make a lateral rather than a midline incision.

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(9) The use of fine black silk sutures is advocated for tendon repair as compared to the use of chromic gut, which often tends to tear the tendon when being passed through its substance, and which also causes more absorption reaction in tissues which frequently have no true circulation but are only bathed in lymph. A wide mattress suture about a centimeter away from the severed ends will approximate the tendon fragments and interrupted single sutures will improve the position of the opposing fiber ends (Figs. 2, 3 and 4).
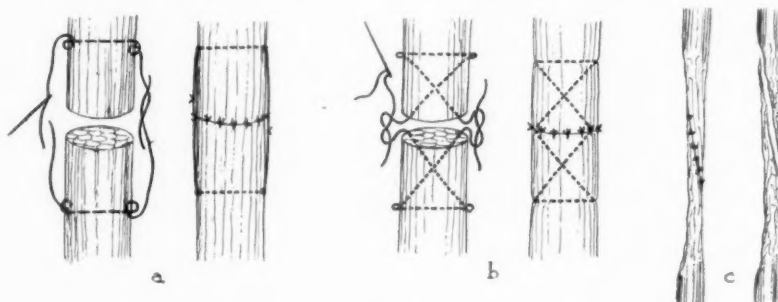

FIG. 2.—Method of approximating the ends of divided tendons. (a) The preferred method. (b) An alternative method. (c) Method of approximating the fragmented ends of scarred tendons when end-to-end union of freshened tendon ends is impossible because of extensive destruction of tissue. (S., G. & O.)

More fanciful stitches are usually unnecessary. Simple approximation is the best.

(10) The loss of substance of a tendon may be overcome by passing black silk sutures through a tunnel formed by a vein taken from another part or limb and then passing the suture through each severed end of the tendon.
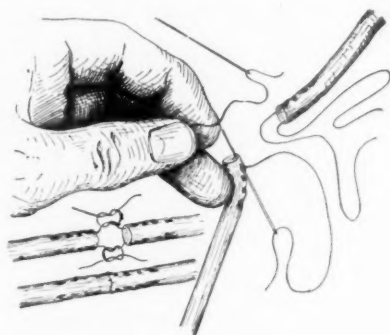
FIG. 3.—Bunnell's method of approximating the ends of divided tendons. (J. Bone and Joint Surg.)
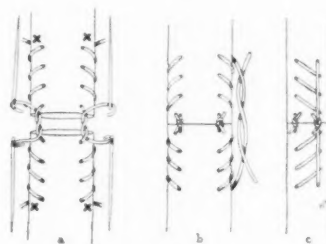
FIG. 4.—Harmer's method of approximating the ends of divided tendons. (Boston M. & S. J.)

Within a space of a few weeks fibroblasts will have formed a new pseudotendon.

(11) In lacerations of both digital flexor tendons between the metacarpophalangeal joint and the middle phalanx, which has been one of the most frequent injuries noted on our service, it is best not to attempt to repair both tendons. Repair only the long flexor—the profundus. If one repairs both at the same level, a large scar tissue growth will develop, causing adhesions

between the tendons and the surrounding soft parts. One slip of the splitting insertion of the flexor sublimis tendon may then be used to form a new annular phalangeal ligament by passing it over the profundus tendon and sewing it to the lateral expansion of the digital extensor tendon. The formation of this new annular ligament will give a much better functional and cosmetic result.

(12) Do not drain these wounds. If drainage is necessary, surgery should not be attempted.

(13) Great effort should be made to cover the repaired tendon or nerve with subcutaneous tissue or fascia before suturing the skin. This usually prevents undesirable adhesions. The skin edges should be carefully sutured to insure primary healing.

(14) A molded plaster splint should be applied to immobilize the fingers and hand in either acute flexion or acute extension to relieve tension on the repaired parts. This splint should be modified and replaced from time to time during the postoperative course as the angle of immobilization is made less acute. The injured limb should be elevated or suspended overhead for four to six days following operation, as these wounds by their very nature are potentially infected. The elevation also will tend to prevent any venous oozing from small unligated venules, and will make the patient more comfortable by relieving him of that distressing and not infrequent postoperative complaint "throbbing."

Postoperative Treatment.—The after care of these patients is just as important as is the operation, if they are to eventually obtain a good functional result. The surgeon should see the patient every day for the first three weeks, and after the initial ten to 14 days, depending on the type of injury, should commence some daily passive motion. I believe these patients would obtain the best functional results if they were hospitalized for three to four weeks postoperatively and not referred to the clinic. Although the expense would be great, the ultimate economic result to the patient would compensate for the added cost. An infection with a resultant "poor" functional result may cause a patient far greater discomfort, disability and loss of earning power than any fracture, hernia or any other form of traumatic injury.

Functional Results Following Tenorrhaphy.—In the earlier years no considered follow up clinic was maintained, and as a consequence the final result of many cases could not be ascertained.

Of the 90 cases which were repaired a follow up was obtained on only 50 per cent of them. Sixty per cent of these had "satisfactory" results. Sixty-four of known end-results of lacerations of the fingers and 70 per cent known end-results of lacerations at the wrist terminated satisfactorily. The remaining 31 per cent had "unsatisfactory" functional results (Table IX).

Of the seven "poor" results five followed infections of the wounds and one was the result of a severe crushing of the carpus in a printing press which later necessitated a low amputation. The remaining "poor" result and

the unfavorable status of the seven "fair" results may be ascribed to such causes as too prolonged immobilization in splints, lack of cooperation on the part of the patient, too elaborate surgery resulting in adhesions of the re-

TABLE IX

FUNCTIONAL RESULTS AFTER TENORRHAPHY

Follow Up of 45 of 90 Repaired Cases

Total Cases Followed....................................	45	
Excellent Result......................................	15	} 31 Satisfactory (69%)
Good Result..	16	
Fair Result..	7	} 14 Unsatisfactory*(31%)
Poor Result...	7	

*12 of 14 unsatisfactory results were in flexor tendons. Of these, 4 were at the wrist, 4 in palm and 4 in fingers.

All poor results caused by either infections, crushing injuries or too long an immobilization in splints.

paired tendons to one another or the neighboring skin, or the sutures failing to hold (Table X).

TABLE X

ANALYSIS OF FORTY-FIVE KNOWN RESULTS

31 Satisfactory Results (69%)				14 Unsatisfactory Results (31%)			
15 Excellent		16 Good		7 Fair		7 Poor	
	7 Ex-	13	3 Ex-		0 Ex-		2 Ex-
8 Flexors	tensors	Flexors	tensors	7 Flexors	tensors	5 Flexors	tensors
5 Wrists	2 Hands	7 Wrists	1 Hand	1 Wrist	(None)	1 Muscles	1 Wrist
3 Fingers	5 Fingers	6 Fingers	2 Fingers	3 Palms		& Ten-	Crushing
				(All Digi-		dons of	Injury
				tals to		Forearm	Gangrene
				Digit III)		2 Wrists	and Am-
				3 Fingers		(Both	putation
				(All Digi-		Infected	1 Hand
				tals to		and De-	(Large
				Digits		veloped	Infection
				II & III)		Claw	Slough)
						Hands)	

INCIDENCE OF NERVE INJURIES.—Further analysis of the records for the past ten years shows that there were 26 severed nerves in 22 patients. Eleven of these patients had associated tendon injuries which have been tabulated previously and 11 were admitted for nerve injuries alone. Fifteen of the injured nerves were in the right arm and 11 in the left arm. Every case of an injured nerve was in a male (one was a young boy). All but four nerves were repaired at operation. The ulnar nerve was most frequently injured, being traumatized in 14 cases, while the median nerve was cut in ten people.

Seven had secondary repairs and 15 had primary repairs. Four patients had both their ulnar and median nerves severed. Twelve of the 14 ulnar nerve lacerations occurred at the level of the wrist (Table XI).

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Complications.—Severed nerves may be complicated by formation of "neuromata" between their repaired ends if there is a poor approximation of the nerve tissues, or a rotation of part of the nerve trunk. "Trophic ulcers" are not infrequent complications, and more commonly found after ulnar
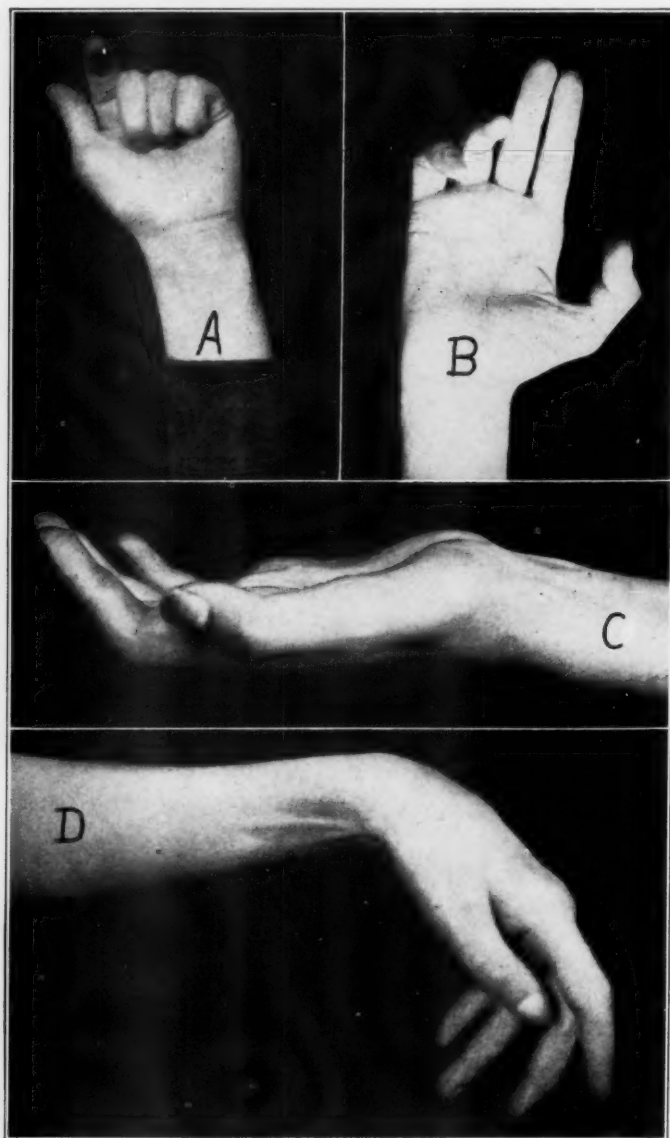

Fig. 5.—Deformities which indicate the nerve severed. (A) Median. (B) Ulnar. (C) Median and ulnar. (D) Radial (drop wrist). (From Morris Anatomy, P. Blakiston's Son & Co., Inc., publishers.)

nerve injury than following severance of the median nerve (Fig. 7). The predisposition for such an ulcer can be accentuated by the excessive pressure of a splint.

TABLE XI

ANALYSIS OF TWENTY-SIX NERVE INJURIES IN TWENTY-TWO PATIENTS

26 Nerves in 22 Cases
11 Cases Had Tendon Injuries
11 Cases Uncomplicated
24 of 26 Injuries Were of the Wrist (2 Forearm)
3 Nerves Not Repaired (Partially Severed)

Right (11)   Left (15)

5 Median Nerves
4 Ulnar   "   5 Median Nerves
1 Radial (Branch)   10 Ulnar   "
1 Musculo-Cutaneous

All Cases Were in Males
4 Cases Had 2 Nerves Severed
12 of 14 Ulnar Nerve Lacerations Were at Wrist
All 10 Median   "   "   "   "   "

Cases $\begin{cases} 12 \text{ in Left Limb} \\ 10 \text{ in Right } " \end{cases}$ Nerves $\begin{cases} 15 \text{ in Left Limb} \\ 10 \text{ in Right } " \end{cases}$

Complications $\begin{cases} \text{Neuromata} \\ \text{Trophic Ulcers} \\ \text{Adhesions to Scars of Tendons} \end{cases}$
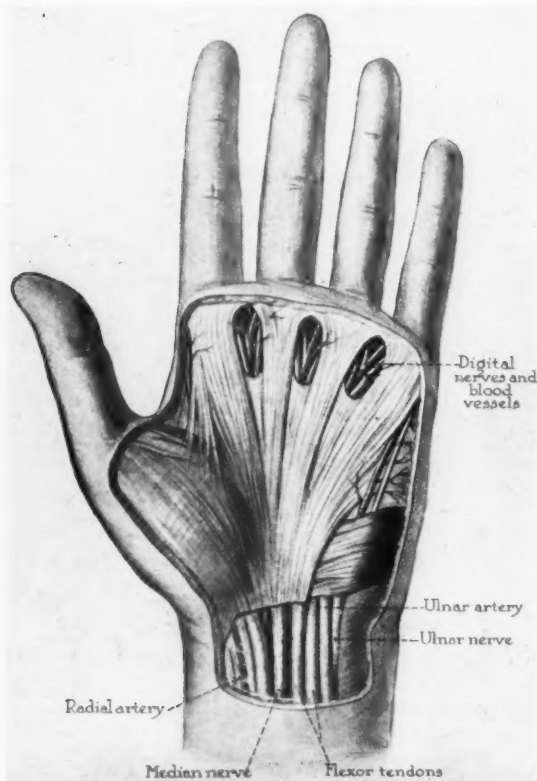

FIG. 6.—Dissection of the volar surface of the wrist showing the superficial position of the median and ulnar nerves, and the similarity in size between the median nerve and the superficial flexor tendons (after Sobotta). (S., G. & O.)

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Adhesions of the tendon scars to the damaged nerve may cause the patient considerable distress. The regeneration of sensory power after ulnar nerve lacerations and repair is more rapid than is the motor function, which
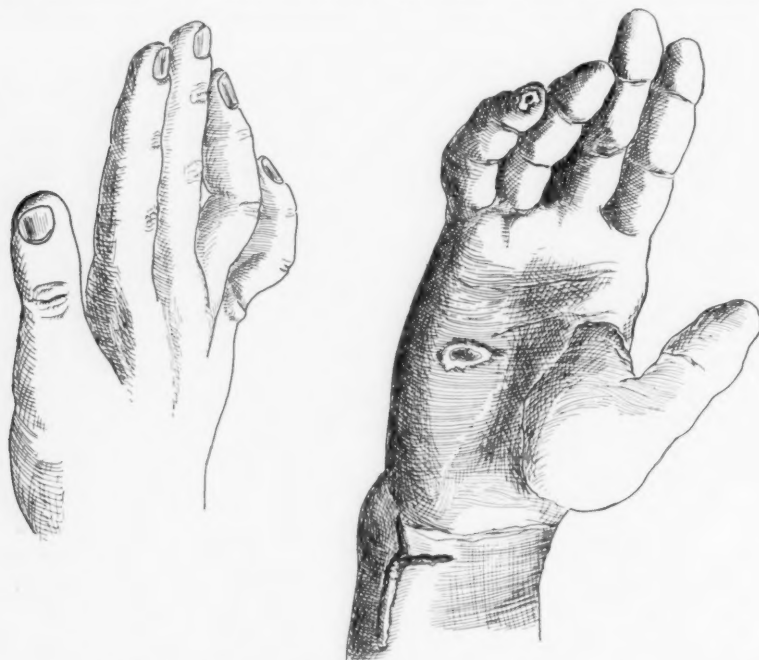

Fig. 7.—Trophic ulcer following severance of ulnar nerve.

frequently may not occur until one year later. Infections are not as dreaded a complication here as they are in tendon injuries and none of the 11 cases which were operated upon for nerve injury alone became infected.
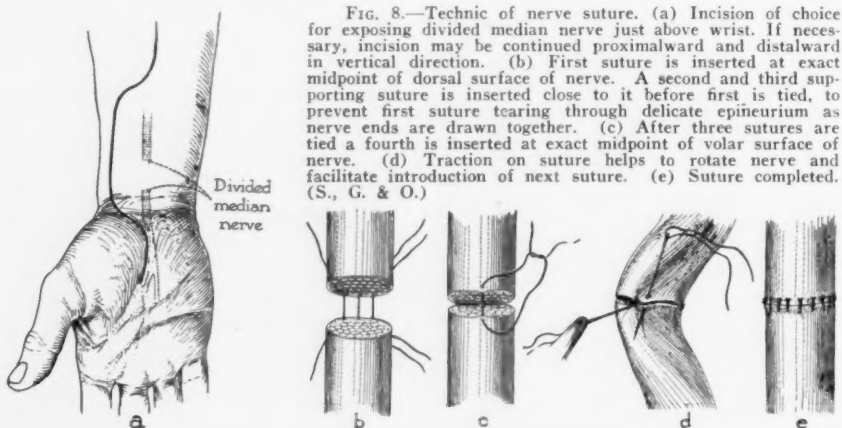

Fig. 8.—Technic of nerve suture. (a) Incision of choice for exposing divided median nerve just above wrist. If necessary, incision may be continued proximalward and distalward in vertical direction. (b) First suture is inserted at exact midpoint of dorsal surface of nerve. A second and third supporting suture is inserted close to it before first is tied, to prevent first suture tearing through delicate epineurium as nerve ends are drawn together. (c) After three sutures are tied a fourth is inserted at exact midpoint of volar surface of nerve. (d) Traction on suture helps to rotate nerve and facilitate introduction of next suture. (e) Suture completed. (S., G. & O.)

Divided median nerve

Technic of Nerve Suturing.—All severed nerves should be sutured with about six to eight interrupted black silk sutures passed through the neurolemma sheath (Fig. 8). In addition, the passing of a suture through the

trunk of the nerve about one centimeter from its severed ends, before free-
ing it from its surrounding soft tissue bed, apparently does not injure any
nerve fibers, as it passes through the substance of the nerve and it has the
advantage of preventing a rotation of the nerve ends after they have been
freed from the surrounding structures
and gives better apposition of the in-
jured parts. The constant irrigation
of the wound with saline while sutur-
ing the nerve diminishes the proba-
bility of the formation in its trunk of
scar tissue due to the absence of any
blood between the opposing severed
ends. Some surgeons advocate the
encasing of the repaired nerve in a
pad of fat (Fig. 9) from the abdom-
inal wall or the surrounding soft parts
so as to prevent adhesions, but this is
usually unnecessary.

A partially severed nerve should
be repaired to prevent scar tissue for-
mation hindering the regeneration of
the nerve fibers in their axis cylinders.
Handle all nerves with the greatest of
care and gentleness. If the nerve was
severed in such a manner as to leave
jagged ends, cut them cleanly across
with a sharp scalpel and approximate
the ends perfectly. Here, as in re-

FIG. 9.—Shows protection of line of suture with
thin fat transplant. (S., G. & O.)

paired tendons, a molded plaster splint must be applied to hold the wrist in
a position where all tension is removed from the repaired nerve for three
weeks' time (which is a longer time than for tendon immobilization).

TABLE XII

FUNCTIONAL RESULTS AFTER NERVE REPAIRS

Follow Up of 13 of 22 Repaired Nerves

5 Excellent Results...............	{ 3 Ulnar
	{ 2 Median
3 Good Results..................	{ 2 Ulnar
	{ 1 Median
5 Poor Results..................	{ 3 Ulnar
	{ 2 Median

Functional Results Following Nerve Suture.—Of the 22 repaired nerves
of the forearm, the end-results of 60 per cent are recorded, showing 61 per

cent are satisfactory. There was no difference in the regeneration of the different nerves as 62 per cent of the ulnar and 60 per cent of the median nerves had their function restored.

CONCLUSIONS

TENDONS.—(1) Primary repairs of tendons should be performed whenever possible. The time between the injury and the operation should be as short as possible and the suture material of choice is fine black silk.

(2) The simple mattress stitch will approximate the tendon ends and destroy fewer lymph channels. More elaborate methods of suture are unnecessary and may be harmful as they tend to diminish the circulation in the tendon and prolong the operation.

(3) Do not repair both digital flexor tendons in the hand. Repair only the long flexor—the profundus.

(4) Repaired wounds should never be drained. If drainage is necessary, do not perform a primary repair.

(5) Infection occurred in 13.33 per cent of the lacerated wounds, and usually resulted in a poor functional result.

(6) The end-result is greatly dependent upon the surgeon's personal management during the first three or four weeks of postoperative care.

(7) A follow up of 50 per cent of the repaired tendon cases is recorded, showing satisfactory functional results in 69 per cent of the cases. Five of the seven known "poor" tendon results followed severe infections.

NERVES.—(1) A partially severed nerve should be repaired in order to prevent the formation of scar tissue, which hinders regeneration of the nerve fibers.

(2) A follow up of 60 per cent of the repaired severed nerves showed satisfactory functional results in 61.5 per cent of the cases.

(3) It is essential to stress the necessity of perfection of the surgical technic and asepsis as well as gentleness in the handling of the tissues in these cases.

PAINFUL SHOULDER

ARISING FROM

LESIONS OF THE SUBACROMIAL BURSA AND SUPRASPINATUS TENDON

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IT IS not the purpose of this paper to discuss all the possible painful lesions of the shoulder region but rather to detail experiences in the treatment of the soft tissue lesions involving the subacromial or subdeltoid bursa and the supraspinatus tendon in 200 patients.

The lesions to be discussed are: (1) Acute traumatic bursitis; (2) acute bursitis with calcification; (3) subacute bursitis with calcification; (4) chronic bursitis; and (5) tendinitis or obliterative bursitis.

It is proposed to outline the significant points in the history and examination of each lesion, to describe as far as possible the pathologic change giving rise to the symptoms, to relate therapeutic measures which have been used, and finally to report the prognosis as observed in a series of cases (Table I).

ACUTE TRAUMATIC SUBDELTOID BURSITIS.—The patients included in this group are those who have pain in the shoulder region following either direct or indirect trauma to the shoulder. The direct trauma may be a blow or fall upon the shoulder, and this is always associated with contusion of the deltoid. Indirect trauma usually results from a fall upon the arm or elbow with the arm in partial abduction. The arm is driven up toward the shoulder by a force transmitted along the long axis of the humerus, or the arm may be forcibly pushed underneath the body by the fall while an effort is being made to produce an abduction movement. Naturally, in many such injuries, the exact mechanism of the trauma cannot be accurately learned, but generally a clear history stating that the shoulder itself did not receive direct trauma may be obtained.

Soon after the injury there is a rather acute tenderness over the greater tuberosity, which becomes less with the passage of time. The patient complains of pain on abduction of the arm. There is often only a portion of the abduction arc in which severe pain is experienced. Usually there is persisting soreness which may be present in decreasing intensity for several days after the injury. On examination, the patient's description of a painful point during abduction movement is confirmed and it may be demonstrated that abduction against resistance is markedly painful even in the lower portion of the abduction arc. Examination should be made for evidence of injury to the acromioclavicular joint as shown by tenderness on pressure over it. In cases with more severe trauma, abduction movements may be very markedly limited due to pain, and in such cases there may be considerable difficulty in making a differential diagnosis between simple acute traumatic bursitis and

partial tear of the supraspinatus tendon. As a matter of fact, however, this differential diagnosis is not important in most cases because treatment of traumatic bursitis and minor tears of the supraspinatus is practically the same.

TABLE I

RÉSUMÉ OF LESIONS CAUSING SHOULDER PAIN

	Acute Traumatic Bursitis	Acute Bursitis with Calcification	Subacute Bursitis with Calcification	Chronic Bursitis	Tendinitis or Obliterative Bursitis
Symptoms	Direct trauma to shoulder. Indirect trauma through arm. Soreness in shoulder	Intense, constant pain in shoulder	Pain in shoulder worse on abduction. Nocturnal. Often history of trauma	History of trauma. Pain in certain degrees of abduction	History of slight trauma or overuse. Slowly increasing pain. Increasing disability in abduction and ext. rotation
Findings	Tenderness over greater tuberosity. Pain on motion, especially abduction	Acute tenderness over greater tuberosity. No shoulder motion because of pain	Tenderness over greater tuberosity. Pain on abduction but motion possible	Tenderness over greater tuberosity. Slight limitation of motion. Pain and click on abduction	Slight deep tenderness, greater tuberosity. Atrophy of shoulder muscles and spasm. Restriction of motion
Cause of symptoms	Traumatic inflammation of bursa due to (1) contusion between greater tuberosity and acromion, and (2) slight tears of supraspinatus tendon	Inflammatory tension in area of calcification	Traumatization of area of calcification in supraspinatus tendon. Reflex spasm of supraspinatus	Thickening of bursa, villi formation and bands	Adhesive bursitis. Loss of gliding function in bursa
X-ray findings	Negative	Large area of calcification over lateral edge of greater tuberosity	Small area of calcification on top of greater tuberosity	Changes in greater tuberosity. Excrescences	Negative
Treatment	Immobilization. Heat. Gradually increasing exercises within pain limits.	Incision and evacuation of calcified area under local anesthesia	Rest, heat, sedative. Local anes. injection into bursa. Exercises within pain limits	Rest, heat. Excision of villi, bands and excrescences	Injection with novocain. Manipulation. Heat, diathermy. Exercises
Prognosis	Good. Recovery in 2 to 3 wks.	Good. Immediate relief of pain. Normal function	Eventually good. Acute symptoms subside in 1 to 3 wks. Eventual recovery	Good. Recovery in 3 to 4 wks.	Eventual recovery. Progress slow

In major or complete tears of the supraspinatus tendon the symptoms are usually so definite that there can be no confusion.

The cause of these symptoms is an acute traumatic inflammation of the subdeltoid bursa. In cases caused by direct trauma, there is an associated

contusion of the deltoid. In those produced by indirect trauma, the inflammation is produced either by the greater tuberosity and the supraspinatus tendon being driven against the acromion or by partial tears at the insertion of the supraspinatus tendon on the greater tuberosity. The latter injury can hardly take place without some injury to the floor of the bursa which lies immediately over the tendon.

A roentgenologic examination should always be made in order to rule out the possibility of fracture.

The treatment of acute traumatic bursitis is immobilization of the shoulder with later applications of heat. A very effective method of immobilization is by means of adhesive strapping (Fig. 1). Moist heat or dry heat by means of an electric pad or diathermy is valuable after two or three days. Immobilization should be continued for a period of at least a week or ten days; then exercises, gradually increasing in range, will permit the patient to recover normal function of the shoulder within a period of three to four weeks after the injury. The difficulty in these cases is in maintaining immobilization and restricted motion long enough to permit the traumatic inflammation in the region of the bursa to subside. The prognosis in these cases is good but it should be remembered that the acute trauma, especially if repeated, may lead to one of the more disabling lesions.

ACUTE SUBDELTOID BURSITIS WITH CALCIFICATION.—There is no mistaking the patient suffering from

FIG. 1.—Adhesive tape strapping of shoulder. Longitudinal strips are fixed first to the arm, beginning about midway between the shoulder and elbow. They are then pulled firmly upward over the shoulder; those from the anterior surface of the arm across the point of the shoulder to lie over the scapula, and in the same manner, those from the posterior surface of the arm cross over the shoulder to become attached to the anterior upper chest. Transverse strips around the arm and across the shoulder fix the ends.

acute bursitis with calcification. He comes nursing the affected arm as tenderly as he would if he had a fractured clavicle (Fig. 2). He refuses to move the arm at the shoulder, and his haggard face confirms his story of sleepless nights because of a constant, intense pain in the shoulder often radiating down the arm. Acute tenderness is found on slight pressure over the greater tuberosity. Further examination can hardly be made because of pain experienced by the patient.

The cause of the acute symptoms in these cases is tension in a calcified area in the supraspinatus tendon in the floor of the subdeltoid bursa. This

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area, which has probably been present for some time, seems suddenly to become the seat of an inflammatory process, and being confined in a dense tissue, the tension produced causes an intense pain. Any attempt to move the arm increases the tension in the calcified area with a consequent increase in the pain.

A roentgenologic examination is of value in confirming the diagnosis. In these acute cases there are two things that stand out in the roentgenogram: the calcified mass appears to be large, and it usually lies well down over the greater tuberosity (Figs. 3A and B).

The therapeutic indication is relief of the tension by incision of the area
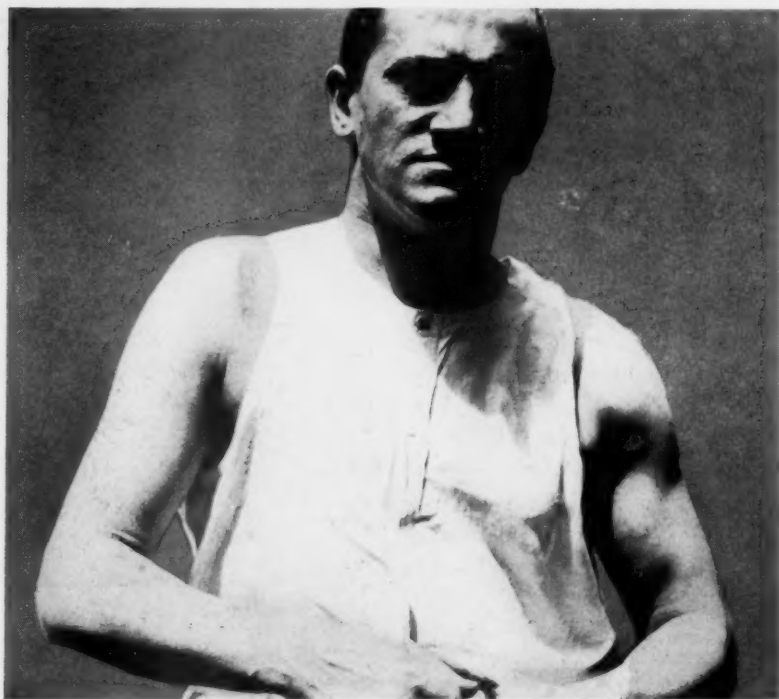

FIG. 2.—Typical position of patient with acute bursitis with calcification of right shoulder.

of calcification, which operation can be performed under local anesthesia, as described by Codman. The use of adrenalin in the novocain makes the operation practically bloodless. A small incision is made over the greater tuberosity, separating the fibers of the deltoid and the roof of the bursa. In typical cases, the lesion is found presenting over the greater tuberosity exactly as Codman describes it. There is a circular red zone of small injected vessels surrounding a pale area of calcification. This area has been found in most cases to lie to the lateral edge of the greater tuberosity. If the incision has been properly placed, the calcified area presents in the wound. If it is not immediately visualized, rotation of the greater tuberosity will bring it into view. Having localized the area of calcification, a small nick in its surface

readily demonstrates the tension which is causing the pain. White, soft mate-
rial of a consistency and appearance of tooth paste pours out of the incision
and curls up in the wound. With this relief of tension the patient experi-
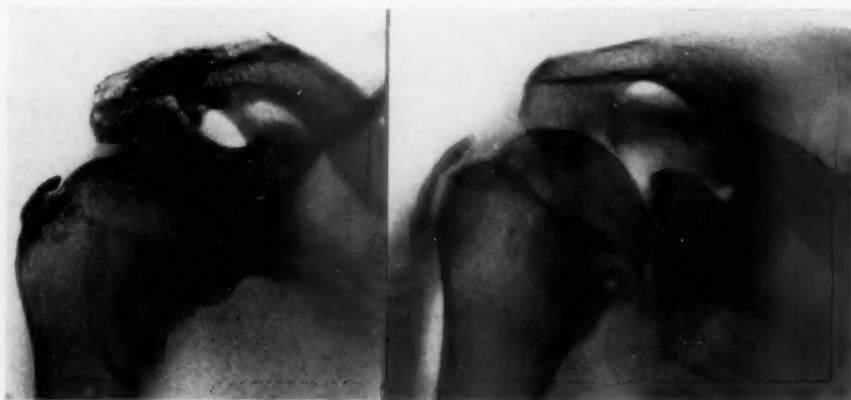

FIG. 3.—(A) Roentgenogram of patient in Fig. 2. (B) Roentgenogram of another similar case. Note typical position and relatively large area of calcium deposit in the acute bursitis with calcification.

ences immediate relief of the intense pain which has tormented him. Usu-
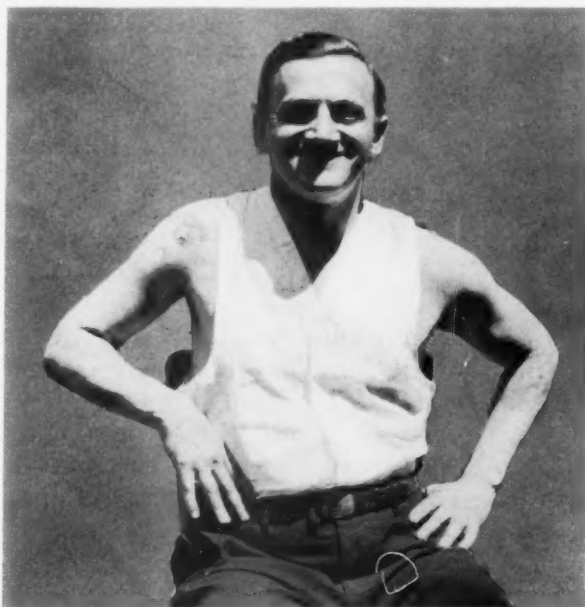ally the incision is enlarged and as much as possible of the calcified material

FIG. 4.—Same patient as Fig. 2, two weeks after incision and evac-
uation of calcified area.

is removed gently with a curette. No effort is made to excise any of the
wall of the calcified area to which clings much of the pasty material. The
wound in the bursa and deltoid is closed with a layer of catgut sutures and

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the skin is closed with mattress sutures of silk. A simple pressure dressing is applied and a sling is adjusted.

This treatment gives such immediate relief from the excruciating pain that the discomfort caused by the wound is minimal in comparison. Five patients so treated have been ambulatory cases (Fig. 4). The prognosis is good in all cases. Immediate relief is followed by recovery without disability in one to two weeks.

SUBACUTE BURSITIS WITH CALCIFICATION.—The patients in this group complain of disabling pain in the shoulder, but it is not so constant or intense as in the former group. The pain does not prevent movement of the arm at the shoulder, but it is caused by abduction so that the movement of putting on a coat causes a sharp pain in the region of the shoulder. As a rule the pain appears if the patient lies on the affected shoulder and is for this reason often noted at night. There is not infrequently obtained a history of previous occasional pains in the shoulder and often of an injury or unusual use of the arm and shoulder.

Examination demonstrates pain on abduction of the arm. Usually it is most acute as the greater tuberosity passes under the acromion. There is tenderness on pressure over the greater tuberosity, but this is not nearly so marked as that noted in the acute type.

Roentgenologic examination shows an area or areas of calcification but these are not usually so dense or so large as noted in the acute variety and they are found located on top of the greater tuberosity rather than along its lateral edge (Figs. 5A and B).

The pathology consists of an area of calcification in the supraspinatus tendon beneath the floor of the bursa. There is no tension in the calcified area and no pain until the area is traumatized either by prolonged or unusual use of the supraspinatus, or by pressure of the area against the acromion in abduction. The supraspinatus is often found to be in a reflex spasm, probably caused by the pain in the region of the calcified area.

The treatment of these cases should be conservative. The indications are rest of the affected arm and shoulder and applications of heat during the painful stage. In about one-half of the cases baking and diathermy are effective in relieving the pain and in causing a rapid subsidence of the symptoms. Sedatives are necessary in the early phases of the treatment. In those cases in which heat and rest are not immediately effective, and especially in those with marked spasm of the supraspinatus, injections of 20 to 30 cc. of 1 per cent novocain into the region of the bursa are often effective. The injection apparently blocks the pain sensations and sets at rest the hyper-irritable supraspinatus. After the more acute symptoms have subsided with either heat or injection, active exercises within pain limits are of most value. The prognosis for eventual recovery is good.

Operation in subacute bursitis with calcification is mentioned only to be condemned. An experience with a few such cases serves to forcefully teach this lesson. The operation itself is often embarrassing, for after opening the

bursa, there is no telltale circular zone of hyperemia to mark the area of calcification. A considerable search is often necessary, in spite of roentgenologic localization, before the dense chalk-like calcified area is found. It is deep in the substance of the supraspinatus tendon and does not present in the floor of the bursa. It seems that perhaps more harm than good is accomplished by making an opening through the tendon at the greater tuberosity in order to remove a relatively innocent appearing area of calcification. The results appear to bear this out, for usually the patient is not relieved of his symp-

FIG. 5.—(A) Case of subacute bursitis with calcification before and after operation. (B) Another similar case. In both of these cases all of the calcification disappeared following operation, but the symptoms persisted.

toms, and his disability increases for a time and sometimes even goes on to a tendinitis.

CHRONIC BURSITIS.—The patients included under this heading are those who complain of pain in the shoulder in a certain range of abduction of the arm. They are usually in the fourth and fifth decades of life, and practically always a history is obtained of either direct or indirect trauma to the shoulder. The trauma is followed by a short-lived, but definite pain in the shoulder, and often there are several such incidents. Eventually, due either to overuse of the arm usually in abduction or to another injury, the pain reappears.

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On examination, there is found little or no limitation of motion of the arm at the shoulder and there is no atrophy or marked spasm. However, when the arm is abducted to a point about where the greater tuberosity passes under the acromion, the patient notices a sharp pain in the shoulder, and he gives a downward jerk of the shoulder. This seems to be a help in passing the painful point because the arm may then be fully abducted without further discomfort. The same painful point seems to be present as the arm is brought to the side again from an overhead position. In addition to the above finding, a click or crepitation may be palpated over the tip of the shoulder in abduction movements. The click is usually felt at the time in the abduction motion when the patient experiences pain. The painful point noted in abduction and the click are not nearly so definite when the arm is raised in the extended position and in some patients this motion may be made without any pain at all.

The cause of these symptoms appears to be a chronic traumatic inflammation of the floor of the subdeltoid bursa, the traumata having resulted in repeated small defects at the insertion of the supraspinatus tendon on the greater tuberosity. These are described by Codman as straps and he believes they are separations of a lamina-like group of strands of tendinous tissue from the parent tendon, which push up in the floor of the bursa in abduction. Trauma may also cause the development of villi which extend across the bursa and are similar to those which are seen in other bursae following repeated injury. Some of these villi appear to be thicker and more fibrous and extend across the bursa in a cord-like string. These have been given the name of bands by Codman. In addition to these changes in the floor of the bursa over the point of the insertion of the supraspinatus tendon, there are often changes in the greater tuberosity itself, as a result of these injuries to the supraspinatus tendon. These changes are easily demonstrable roentgenologically as excrescences at the tip of the greater tuberosity, eburnation of bone and areas of reduced density in the greater tuberosity and adjacent shaft of the bone (Fig. 6).

The treatment of this type of chronic bursitis may be divided into the conservative and the operative treatment. Since the symptoms almost invariably arise from trauma it might be expected that rest of the shoulder and applications of heat might give good results in many cases. This reasoning has proved correct in the majority of our cases. However, in a few patients, where symptoms persist in spite of conservative therapy, incision of the bursa and excision of the offending villi, bands, straps, or excrescences seemed logical. This therapy has been successful in the four cases in which it has been used.

The prognosis in chronic bursitis is good. As a rule, under conservative therapy, relief of symptoms may be obtained in three to four weeks. When symptoms persist beyond this time, operative intervention is indicated, with the prospect of relieving the symptoms in another three to four weeks. In one patient there was complete relief of all symptoms 15 days after the re-

moval of hypertrophic villi and several small excrescences from the great tuberosity.

TENDINITIS OR OBLITERATIVE BURSITIS.—The cases included in this group are those which have commonly been described under the headings of bursitis, periarthritis or neuritis of the shoulder and arm. These patients are practically all 40 or more years and there is generally a history of direct or indirect trauma to the shoulder or of overuse of the arm. The pain in such cases appears to develop slowly and to increase gradually over a period of weeks. Characteristically, the pain appears somewhat lower down over

FIG. 6.—Rarefaction at the greater tuberosity.

the deltoid than in the other lesions previously described, although this is not invariable, and there is usually a radiation of the pain down the arm to the elbow and extending even as far as the hand. In addition, there is at times a radiation of the pain upward over the neck and scapula. The pain appears to be worse at night and the patient usually complains that he is unable to sleep on the affected side. Any attempt to move the arm away from the body either in abduction or in extension causes pain.

On examination, there is usually noted marked atrophy of the deltoid and other shoulder muscles. Tenderness on pressure over the greater tuberosity and well down along the humerus toward the deltoid tubercle is usual. Attempts to abduct the arm are restricted by an apparent fixation of the struc-

tures in the region of the shoulder; thus has arisen the term "frozen shoulder" as applied to this condition. Efforts to passively abduct the arm demonstrate the marked involuntary spasm of the shoulder muscles which is so character-istic of these cases. Not only is it impossible to abduct and extend the arm at the shoulder but in many instances rotation, especially external rotation, is impossible.

The pathologic process which appears to cause the symptoms is a chronic adhesive bursitis in which there is a functional loss of the gliding mechanism in the subdeltoid bursa. The adhesions are, as a rule, traumatic in origin and are probably the result of frequent minor traumata to the bursa and of tears in the supraspinatus tendon producing subacute symptoms.

Roentgenologic examination usually shows few or no changes in the greater tuberosity although in a few cases there may be a roughening at the edge and, in some, excrescences appear along the tip of the acromion.

These patients are among the most difficult of all to treat. Their arms are practically useless, especially if their occupation demands abduction. The treatment should consist in stretching or rupture of the adhesions so that the gliding function of the subdeltoid bursa may be resumed. Conservative treat-ment consists in applications of heat, usually in the form of diathermy, with exercises within pain limits. Under this therapy progress is slow and often discouraging to the patient although recovery will almost invariably take place after a period of months. A second method of treatment which has proved more successful, in a majority of our patients, has been the injection of 20 to 30 cc. of a 1 per cent novocain solution into the region of the subdeltoid bursa. The injection has a twofold purpose, one of stretching and dilating the tissues in the region of the bursa and thus providing for some gliding movement and, second, the injection being anesthetic, it produces a more or less complete relief of painful stimuli from this area and so permits manipu-lations of gradually increasing range. The manipulations should be carried out at first carefully and slowly to the limit permitted by the adhesions. As a rule, internal and external rotation movements are first tried, followed by circumduction movements at the shoulder with a gradually increasing range. During the manipulations there may often be a palpable and even an audible snap, after which practically full range of motion may be obtained. In some cases, when the pain is too marked to permit adequate manipulation, it has been found advisable to give a second injection of novocain.

For the first 24 hours after the injection and manipulation there may be an increase in the pain and soreness in the shoulder. This may persist for a day or two in decreasing intensity. Thereafter the discomfort usually sub-sides except on movement of the arm.

The best results, of course, are obtained when there has been a sensation of a snap or rupture of an adhesion during manipulation. These patients obtain almost complete range of motion of the shoulder without discomfort after a week or two. In the patients treated without injection, exercise is an important therapeutic measure. Codman's stooping exercises, in which the

patient leans forward and swings the arms forward and backward trying each time to bring the arm as far as possible towards the head, have been found to be a very useful procedure. In some patients the swinging of some heavy object, such as a dumbbell or an old fashioned flat-iron, has provided an increased inertia sufficient to stretch the adhesions and provide an increased range of motion. Another exercise which has proved valuable is so called wall climbing in which the patient creeps up the wall with his fingers (Fig. 7). It is useful in some cases to have the patient mark the upper limit which he can reach so that he may note his daily progress by the

FIG. 7.—Wall climbing exercise. The patient creeps up a vertical wall with his fingers.

FIG. 8.—Abduction exercise to stretch adhesions in the shoulder bursa. The patient grasps an object at his side. Abduction motion is increased by bending the knees.

increasing height to which his fingers will obtain. Abduction exercises are provided by having the patient grasp some object at his side. Then by bending his knees abduction is obtained at the shoulder. Patients are often less timid about producing abduction by knee bending with the arm fixed than by moving the arm with the body fixed (Fig. 8). Another exercise which will utilize the same principle is one in which the patient grasps a banister, table or some other object about waist high. He then backs away from the object with his hands still in place; by bending the knees further stretching of the adhesions is produced (Fig. 9).

All of these exercises may be carried on in the home and the faithfulness and effort of the patient is a big factor in his progress. Some patients may improve in a period of three to four weeks, sufficient to obtain almost normal

function in the shoulder joint. In others the progress may be slow, but the prognosis for eventual recovery and normal shoulder function is good in practically all cases, although a degree of recovery approaching the normal may not take place for as many as 6 to 12 months.

COMMENT.—The above outline of the diagnosis and treatment of painful shoulder due to lesions of the shoulder bursa and the supraspinatus tendon presents the subject in much more simple fashion than is often encountered clinically in the patient. In spite of definite criteria upon which the diagnosis is made, a differential diagnosis is often difficult for the reason that many of

FIG. 9.—Adhesions in the shoulder bursa being stretched by grasping some waist-high object and backing away from it. When the patient has reached the pain limit, additional stretching is obtained by bending the knees.

these lesions may be combined or may follow one another, the one leading to the other so that the history is by no means clear and the findings may fit into several diagnoses. In other instances the diagnosis may be confused by other injuries in the shoulder region, such as dislocation of the shoulder, fracture of the greater tuberosity or of the upper humerus. In spite of these facts, however, an adequate history and a careful physical examination will as a rule give the examiner a fairly clear mental picture of the pathologic process with which he is dealing. This is important because the success of the treatment depends in large part upon an exact knowledge of the lesion being dealt with.

A statement should be added regarding the effect of toxic absorption and focal infection upon the production and course of these lesions. Since the

possibility of such an effect has been mentioned in many discussions of the etiology of chronic bursitis and tendinitis and even of those cases with calcification in the supraspinatus tendon, in many of the cases observed an investigation of possible foci of infection has been made, including the colon as a source from which toxic absorption may occur. In those cases in which foci of infection were found and eradicated no special benefit seemed to follow, and it has never been possible to definitely trace etiologic relationship between the painful lesions described and toxic absorption from foci of infection or from the colon. The constancy with which a story of trauma appears in the history of patients with painful lesions of the shoulder points to the relative importance of injury as the outstanding etiologic factor in these cases.

DISCUSSION.—DR. DONALD GORDON (New York). In regard to acute traumatic subdeltoid bursitis, I would add nothing except that in my experience I have found that a simple axillary pad, sling and swathe, make a more comfortable and efficient immobilization of the shoulder than adhesive plaster. This can be done with two bandages and a bundle of cotton and a few safety pins. It is easily removed for examination and therapy, which the adhesive does not permit. Doctor Ferguson does not mention an axillary pad; but where there is much space between the arm and the body at the elbow, close approximation of the arm to the body without a pad causes pressure on the bursa through the tense deltoid pressing on the swollen bursa by this arm adduction. I feel he does not sufficiently stress the danger of this type progressing to the "frozen shoulder," so called, by reason of inadequate treatment; though he feels as I do, that this is a common precursor of the shoulder with muscular contracture. In cases of this kind where severe pain has existed for a few days with much muscle spasm, I use immobilization and ambulatory traction, which I would like to suggest as an efficient therapeutic measure, when operation is not indicated or consented to.

The late Doctor Brickner of New York was one of the first to operate upon cases of calcified bursitis, the pathology of which Dr. Eli Moscowitz has described so well, but who had observed that these calcified areas frequently disappeared without operation. The largest conically shaped mass I have ever seen disappeared in ten days without operation. We are all familiar with the fact that these opacities are present in shoulders which are not painful, as well as in those which are painful, in the same patient. I have found it difficult to understand, if these areas of calcinosis are due to trauma alone, how further trauma by operation could cure them unless it was by aiding vascularization in an area of marked ischemia.

Curiously similar lesions are rarely seen, if at all, following fractures about the greater tuberosity, where the fracture lines have opened up a new vascularity, although there is an increase in the possibility for trauma due to the slightly elevated fragment. Also we do not get the bursal syndrome if muscular contracture has been avoided. The short period of recovery, however, in Doctor Ferguson's cases is the best criterion of the efficacy of the procedure in his hands whatever may be the academic view of the pathology.

I am unable to understand how, with the similarity of pathology and symptoms between subacute bursitis with calcification and the acute variety, operation is not of service if it releases tension only, unless the calcinosis being in the supraspinatus tendon, it is in a more avascular area than when it lies in the floor of the bursa.

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I have never tried the injection of novocain, because I felt that it was a temporary sedative which would not correct the pathology. However, if such blocking of the protective mechanism will permit sufficient muscular activity without pain, to prevent atrophy of disuse and loss of coordination, its use should be of real value, and I feel that this is the basis for part of its success in Doctor Ferguson's hands. I feel also that the needling associated with such anesthesia must of necessity be of value in vascularization. Furthermore, if anesthesia permits increased function, and trauma has been an exciting factor, I am again at a loss as to why it cures, unless this type of lesion has the pain of contracture, which limited exercises correct if they can be done without pain.

Doctor Ferguson described the causative pathology of the symptom complex of tendinitis as due to "a chronic adhesive bursitis in which there is a functional loss of the gliding mechanism in the subdeltoid bursa." If it is a chronic adhesive bursitis, why call it tendinitis? The latter term seems to me to apply more aptly to his classification with calcinosis in the supraspinatus tendon insertion. Also there are many structures which move on each other in scapulohumeral movement. In fractures of the greater tuberosity, where there must be bursal adhesion and tendon injury, I have not seen this symptom complex.

The limitation of shoulder movement in these cases I believe is due to muscle contracture following prolonged muscle spasm caused by splinting the painful shoulder rather than spasm alone, which must be carefully differentiated for the purpose of treatment. The pain referred to the deltoid insertion, extending up the cervical plexus and down the arm to the hand, is present only when muscle contracture exists. Improvement in pain is directly proportionate to the improvement in muscle contracture. If novocain will permit the gentle stretching which is imperative in connection with other therapy, I think it is an excellent point.

Doctor Ferguson states that in his experience with cases studied "it has never been definitely possible to trace etiologic relationship between the painful lesions described and toxic absorption from foci of infection, or the colon." This is contrary to my experience. To cure patients of these lesions, I cannot overlook foci of infection as an etiologic factor however indirect the relationship. I am almost convinced from experience, that his last group is one of arthritis or periarthritis.

GAS GANGRENE

A REVIEW OF THIRTY-TWO CASES WITH SPECIAL REFERENCE TO THE USE OF
SERUM, BOTH PROPHYLACTIC AND THERAPEUTIC

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GAS gangrene is a condition which assumes considerable importance in military surgery but which has been relatively uncommon in civil practice. Of later years, however, it is being seen more and more frequently. To a certain extent its increasing occurrence in rural districts is due to more complete mechanization on the farms with a correspondingly greater incidence of severe mechanical injuries. Because of this fact and the high mortality with which it has been accompanied, any advance in the treatment of gas gangrene is significant. The vast experience obtained during the World War led to considerable progress in the treatment. Since that time the greatest advance has been in the use of serum, which was only in the developmental stage during the War. It is with our experience with the use of serum, both prophylactic and therapeutic, that this review is primarily concerned.

In 1932, a series of 18 cases of gas bacillus infection which had been treated were reviewed and presented at the seminar of the surgical department. This group represented all cases of gas bacillus infection which had been seen on the surgical service between the years 1926–1932. The mortality in this series was 50 per cent, which was no improvement over that of the A. E. F. Prior to this review, our treatment had been almost entirely surgical, and serum, both prophylactic and therapeutic, had received only slight attention. Because of the discouraging results in this group of cases, and influenced by the reports in the surgical literature regarding the use of polyvalent serum, the latter was introduced into the treatment of our patients. As 18 additional cases have been observed since the introduction of the serum into the treatment of gas gangrene in this hospital, an analysis of these two groups of cases seems warranted.

This analysis has attempted to answer the following pertinent queries:

(1) Has there been a decrease in our mortality rate which justifies the continuance of the use of serum?

(2) If so, is this due to the use of serum *per se*, or to other factors, such as a difference in the type of case which is complicated by gas bacillus infection?

(3) Is the continued use of prophylactic serum to be recommended?

(4) Has serum therapy made possible the use of less radical surgical procedures, such as the use of débridement in cases which would otherwise require amputation?

Before attempting to supply an answer to these questions a few important

points regarding the etiology and pathology are worthy of emphasis. While we commonly speak of the condition as a C. welchii infection, this is only a part truth. There is a fairly large group of anaerobes, the members of which have many characteristics in common, but with individual potentialities when implanted in living tissue. One organism may produce gas; another by putrefaction of tissue causes odor; while still another may cause edema. It it obvious then that the clinical evidence of infection will depend upon the particular etiologic agent and these manifestations may be modified by various combinations of organisms. One must be familiar with the manifestations of these various organisms and not depend upon any one feature of the condition, such as odor or gas, when making the diagnosis. A very striking example of this is presented by Ghormley[1] in which there is a brief account of a case characterized by edema and at no time was there gas in the tissues or an odor suggestive of gas bacillus infection. Cultures revealed vibrion septique.

TABLE I

BACTERIOLOGY OF GAS GANGRENE

(1) Clostridium welchii (B. perfringens: B. aerogenes capsulatus.)
    The etiologic agent in about 80 per cent of cases.
(2) Vibrion septique (Clostridium oedematis maligni)
    Found in 10 per cent of cases
(3) C. oedematiens
    Found in 3 per cent of cases
(4) C. histolyticus
(5) C. fallax

The anaerobic organisms may also be conbined with pyogenic bacteria. The reports of the Surgeon-General state that the occurrence of Streptococci in symbiosis with the anaerobic group greatly increased the virulence of the infection; on the other hand the association of Staphylococcus seemed to produce less virulent infections than with anaerobes alone.

The anaerobes occur in the intestines of man and animals and in fertilized soil. The spores have been isolated from new woolen clothing and blankets. A consideration of the habitat of these organisms together with an understanding of the pathology present in gas gangrene permits us to predict the type of injury in which gas bacillus infection is likely to occur and provides some guidance as to the prophylactic measures which should be taken to prevent its occurrence.

Gas gangrene is essentially a disease of devitalized tissue, the favorite location being muscle which has been traumatized. The spread of infection tends to be in the long axis of the muscle rather than transversely from one muscle to another. Upon this conception of the pathology is based the rationale of débridement and excision of involved muscle as a means of avoiding amputation. However, in cases where the main blood supply to a part has been damaged, the entire limb may undergo a rapid massive gangrene. In such a case débridement is ineffective and amputation is a safer procedure.

The infected muscle tissue becomes brick-red in color, swollen and edematous; bleeding is less brisk than normal and there is a loss of muscular con-

tractility.   Later the muscle becomes lifeless and assumes a blackish-green appearance.

The conditions suitable for the development of gas gangrene are most often found in severe lacerations and compound fractures.   In addition, there have been reported cases following operations on the biliary or intestinal tract, following delivery, after hypodermic injections, following catheterization, after gunshot wounds, and after amputations, particularly those which have been performed for arteriosclerotic or diabetic gangrene.

These few points are briefly reviewed in order that we may be alert to prevent the development of a condition which has previously carried with it a mortality of 50 per cent.   This prophylactic treatment applies particularly to contaminated lacerations and compound fractures.   Prophylactic serum has been previously recommended as a preoperative procedure to be desired in amputations for diabetic and arteriosclerotic gangrene.

In the previous report 18 cases were reviewed.   Two of these cases have been omitted from this report because a positive culture of C. welchii was not obtained.   Clinically, however, these were definite gas bacillus infections, one of which died and the other lived.

Positive C. welchii cultures have been obtained on all cases reported in these two groups.   Cases presenting a positive culture, but with no clinical evidence of infection, have been omitted.

TABLE II

GROUP I (1926–1932)

Number of Cases	Died	Recovered	Mortality Per Cent
16	8	8	50%

Table II represents the 16 cases occurring between the years 1926–1932.

TABLE III

GROUP II (1932–1936)

Number of Cases	Died	Recovered	Mortality Per Cent
16	3	13	18%

Table III represents the cases occurring between the years 1932–1936.

TABLE IV

CONSOLIDATION OF GROUPS I AND II (1926–1936)

Number of Cases	Died	Recovered	Mortality Per Cent
32	11	21	34%

Group II shows a substantial reduction in the mortality.   This, we believe, is due primarily to the therapeutic use of serum, there having been no other change in our method of treatment.

In any such comparison of groups of cases, the type of injury which is complicated by gas gangrene must necessarily be considered.   It is well known that those cases in which there is considerable trauma and muscle damage present the more virulent and more fatal examples of the condition.

A comparison of Tables V and VI shows a decrease in the incidence of compound fractures which are complicated by gas gangrene in the later series.

TABLE V

TYPE OF CASE COMPLICATED BY GAS GANGRENE (1926–1932)

	No. Cases	Recovered	Died
Compound fracture tibia and fibula..............	3	3	0
Compound fracture humerus..................	2	1	1
Compound fracture radius....................	1	1	0
Compound fracture femur.....................	1	0	1
Compound fracture metatarsals................	1	0	1
Burn of legs................................	1	0	1
Typhoid perforation of ileum..................	1	0	1
Hypodermoclysis (thigh).....................	2	1	1
Leg amputation (diabetes)....................	2	0	2
Bismuth injection (buttock)..................	1	0	1

TABLE VI

TYPE OF CASE COMPLICATED BY GAS GANGRENE (1932–1936)

	No. Cases	Recovered	Died
Compound fracture forearm...................	2	2	0
Compound fracture tibia and fibula............	2	2	0
Leg amputation (diabetes)....................	5	3	2
Fractured humerus with thrombosis of axillary artery......................................	1	1	0
Leg amputation (A. S.).......................	1	1	0
Laceration (caused by rotary hoe)..............	2	2	0
Burns.......................................	2	1	1
Frost-bite (feet—bilateral)....................	1	1	0

It is our impression that this is to be explained by the more frequent use of prophylactic serum in compound fractures seen since 1932. The frequency of gas gangrene in amputation stumps, particularly in diabetics, has been pointed out by previous observers. We have had eight such cases, with a mortality of 50 per cent. Group I presents two cases of gas bacillus infection developing in the thigh following hypodermoclysis. One of these followed an interval appendicectomy and resulted fatally. The second case followed drainage of an appendiceal abscess. This case responded satisfactorily to débridement of the involved area of the thigh.

It is obviously impossible to draw any conclusions from such a small series of cases as to the influence which type of injury exerts on the mortality rate. Despite the greater number of compound fractures in Group I, we do not feel that this is the entire explanation of the better results in the second series.

The smaller mortality rate in the second series is not due to any change in the surgical treatment of the condition. In both series of cases amputation has been performed much more frequently than débridement when the infection has involved an extremity. Débridement has, necessarily, been the procedure when the infection involved the trunk. Our opinion is, however, that the use of prophylactic and therapeutic serum will in the future make possible the use of less radical surgery. This does not mean that incomplete surgical attack combined with serum can cope with the infection, but merely that serum may permit the substitution of thorough débridement for amputation. Nevertheless, amputation will always have a place in the treatment of this condition. Each case must be individualized in arriving at a decision

as to the surgical procedure which should be undertaken. Cases presenting interference with the main blood supply of an extremity will in most instances develop a massive gangrene and in these amputation rather than débridement should be performed. The degree of injury to an extremity may at times be sufficient so that amputation would be indicated even though gas bacillus infection were not present. Débridement, if it is performed, must be thorough; the standards upon which one bases a judgment as to the degree of involvement of muscle are its color, its contractility and the ability to bleed when it is cut. If amputation is performed, the level at which it is done and the type of amputation must receive consideration.

The Value of Serum as a Prophylactic Measure.—Its value as a means of preventing gas bacillus infection cannot be definitely established at the present time. This information can be obtained only by inference after its use in a large series of cases of the type in which gas gangrene would be likely to develop. Of those cases which have had a prophylactic dose of serum we have no means of knowing how many would or would not have developed clinical evidence of infection if it had not been given. In Group I, no prophylactic serum was used. In Group II, one case developed clinical gas bacillus infection despite a dose of prophylactic serum.

Case Report.—V. F. A male, age 36, was admitted to the hospital August 26, 1934. Three hours previously the wheels of a wagon passed over his right leg. Examination showed a compound fracture of the right tibia and fibula. There were areas of decreased density in the soft tissues suggestive of either gas or air. There was a ragged wound over the medial aspect of the tibia contaminated by dirt. He was given a prophylactic dose of combined gas bacillus (1,000 units perfrigens, 1,000 units septique) and tetanus antitoxin (1,500 units). The wound was débrided, partially sutured, and a posterior molded plaster splint applied. In 12 hours he was complaining of severe pain in the leg. At this time inspection revealed no gas, odor or crepitus but considerable swelling. Temperature 98.6° F., pulse 100. The pain continued. Twenty-four hours following débridement and serum, the patient became irrational, temperature rose to 102.8° F., and pulse to 140. Inspection revealed the characteristic odor, crepitus extended three inches above the knee. Polyvalent serum (10,000 units) was given intravenously and a guillotine amputation was performed at the midthigh. Polyvalent serum (10,000 units) was given eight hours later. Twenty-four hours after the thigh amputation crepitus could be elicited in the right buttock. Extensive débridement of all involved tissue was carried out. Therapeutic serum was given at eight-hour intervals, 21 doses being given during his illness. During convalescence crepitant areas developed over the elbow and shoulder from which C. welchii was recovered. A positive blood culture was never obtained. Convalescence was slow and skin grafting was necessary to cover the large granulating area on the buttocks. He was discharged from the hospital five months after the original injury.

Our experience with this patient, developing gas gangrene despite prophylactic serum, does not stand alone. Warthin,[2] and also Ghormley,[1] give the impression that they have had similar experiences. These authors, as well as several others, felt that in those cases which do develop infection the disease is appreciably modified by the use of prophylactic serum.

We have not allowed this experience to disturb our faith in prophylactic serum. It is well known that clinical tetanus has developed despite prophy-

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lactic tetanus antitoxin. Warthin recommends a second dose of prophylactic gas bacillus serum within 12 hours. This additional measure or perhaps an increase in the original dosage may be indicated.

THE USE OF SERUM AS A THERAPEUTIC MEASURE.—The evaluation of therapeutic serum is more tangible. It has been shown that the chief difference between Groups I and II is in the more frequent use of therapeutic serum in the latter group. In Tables VII and VIII, the mortality of the cases having serum is compared to those treated without serum.

TABLE VII

THERAPEUTIC SERUM GROUP I (1926–1932)

	No. Cases	Died	Recovered
Antitoxin given...............	2	0	2 (100%)
Antitoxin not given...........	14	8 (57%)	6 (43%)
Totals.....................	16	8	8

TABLE VIII

THERAPEUTIC SERUM GROUP II (1932–1936)

	No. Cases	Died	Recovered
Antitoxin given...............	14	2 (14%)	12 (86%)
Antitoxin not given...........	2	1 (50%)	1 (50%)
Totals.....................	16	3	13

TABLE IX

CONSOLIDATION OF GROUPS I AND II

	No. Cases	Died	Recovered
Antitoxin given................	16	2 (12%)	14 (87%)
Antitoxin not given...........	16	9 (56%)	7 (44%)

A comparison of the two groups shows a mortality of 12 per cent in those cases having serum as contrasted with a 56 per cent mortality in cases treated without serum.

The number of injections given in our cases has varied from 1 to 21, the majority of cases having but one or two doses. Ghormley observed that those patients who react favorably to the serum do so after one dose has been given. This has also been our impression. We believe, however, that the serum should be repeated every four to eight hours as long as there remains evidence of infection, as manifested by elevation of temperature, increased pulse, mental clouding or local signs. The intravenous method of administration is preferred.

There has always been considerable discussion as to the relative efficacy of the various chemicals used as local applications. Hydrogen peroxide, quinine solutions and Dakin's solution have had their advocates. For the most part we have used hydrogen peroxide. It seems doubtful if it makes any material difference if such solutions are used or not. Adequate surgery, therapeutic serum and the avoidance of occlusive dressings are the essentials.

Present Method of Treatment.—Prophylactic: A knowledge of the type of injury or condition which is most likely to be complicated by gas bacillus infection is the first essential. Compound fractures and lacerated wounds which are contaminated have been the chief offenders. In such cases

a thorough mechanical débridement removes the devitalized tissue. If the wound is left open an aerobic environment is provided which is a further hindrance to the growth of the anaerobic organisms. In such cases the giving of gas gangrene antitoxin should be as much a routine as the giving of tetanus antitoxin. For this the combined gas gangrene and tetanus antitoxin should be used. This contains 1,500 units of antitetanic serum and 1,000 units each of C. welchii and vibrion septique antitoxin.

Direct smears from the wound may show the organism. This does not necessarily mean an infection, as it is well known that the organisms may be present without clinical evidences of infection ever developing.

The use of prophylactic serum is particularly recommended as a pre-operative measure for patients who are to undergo amputation for arterio-sclerotic or diabetic gangrene. Such cases have made up 25 per cent of our cases of gas gangrene. In this special group there has been a 50 per cent mortality.

TABLE X

CASES OF GAS GANGRENE IN AMPUTATION STUMPS

	No. Cases	Died	Recovered
Antitoxin given	4	1	3
Antitoxin not given	4	3	1

Diagnosis.—In the typical and advanced case the diagnosis can hardly be missed. The odor, the crepitus, the muscle and skin discoloration, are findings too evident to allow even the most careless observer to ignore them. Gas in the tissues may often be demonstrated by percussion much earlier than crepitus can be elicited. The finding of gas in roentgenographic study may also be a considerable aid in making an early diagnosis. One must remember that the finding of such areas in the soft tissues may be due to entrapped air and be independent of gas bacillus infection.

Early diagnosis of the condition is imperative if treatment is to be effective. More pain than should normally occur from the injury or operation is one of the earliest signs. An increasing pulse rate is of more significance than the temperature, which may not be markedly elevated. In a considerable number of our cases the patients have been irrational.

Treatment of the clinical infection consists of a judicious combination of surgery and serum. All involved tissue is removed either by débridement or amputation, as conditions demand. The wound is either left open to the air or a light dressing saturated with hydrogen peroxide is applied. Therapeutic doses of polyvalent serum are given either intramuscularly or intravenously at intervals of four to eight hours until there is a satisfactory response. The local area is watched carefully for evidence of recurrence of infection, and if this develops it is treated accordingly. Blood transfusions are an important part of the treatment because of the rapid hemolysis which not infrequently takes place.

Irradiation therapy has been recently advocated as an auxiliary method of treatment. This, however, has not been used in the group of cases cited, but

in the future it will be given a thorough trial. We expect that it will have its greatest applicability in those cases in which there is an associated Streptococcus infection. This expectation is based on the excellent results which we have observed when it has been used in the treatment of erysipelas and other Streptococcic infections.

Five additional cases have been seen during the past year by my associate, Dr. F. W. Fordyce, and myself. These cases were not seen by us until after a definite gas bacillus infection was present. A brief summary of these cases is presented.

TABLE XI

	Sex	Age	Injury	Prophylactic Serum	Operation	Therapeutic Serum	Roentgen Therapy	Result
1.	F	10	Laceration of leg	Yes	Débridement	Yes	Yes	Recovery
2.	M	9	Laceration of leg	Yes	Amputation	Yes	Yes	Recovery
3.	M	9	Cmpd. frac. of humerus	No	Amputation	Yes	Yes	Recovery
4.	M	37	Laceration of arm	No	Débridement	Yes	Yes	Recovery
5.	M	9	Laceration of leg	No	Débridement	Yes	Yes	Recovery

This group is of interest inasmuch as two cases developed gas bacillus infection despite the use of prophylactic serum. They present additional evidence that prophylactic serum without intelligent surgery cannot be expected to prevent the development of gas gangrene.

CONCLUSIONS

(1) In a group of 16 cases of gas gangrene treated without serum the mortality was 50 per cent. In a group of 16 cases in which serum was an essential part of the treatment, the mortality was 18 per cent.

(2) Prophylactic antitoxin should be used in all wounds potentially infected by gas bacilli. The occasional case which develops gas gangrene, despite prophylactic serum, does not prove its inefficacy, but does suggest that an increase in prophylactic dosage, or an early repetition of the injection, may be advisable.

(3) Prophylactic serum should be given preoperatively to patients who are to undergo amputation for diabetic or arteriosclerotic gangrene.

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A CORRELATION OF ROENTGEN RAY DOSAGE AND NECROPSY FINDINGS IN A CASE OF RETROPERITONEAL AND MEDIASTINAL METASTASES FROM EMBRYONAL CARCINOMA OF THE TESTIS

DEATH FROM GANGRENE OF THE COLON, THE RESULT OF IRRADIATION THERAPY

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The value of irradiation in the treatment of malignant testicular neoplasms has long been recognized because such neoplasms usually exhibit a high degree of radiosensitivity. However, there is little evidence to indicate what might be regarded as an adequate "carcinomacidal dose" for these tumors. The following case history is presented because it is an instance of extensive, deeply seated metastases from such a neoplasm, that were clinically controlled for 18 months, with necropsy at the termination of this period following death from intercurrent disease, permitting an histologic study of the effects of the irradiation. In the literature there are few reports of necropsy findings in patients with deeply situated malignant tumors who were clinically well from the disease as a result of external irradiation. In the present state of knowledge concerning the reaction of malignant neoplasms in vivo to irradiation, cumulative reports of this nature would contribute to the advance of irradiation therapy.

Case Report.—W. K. (103384), white, male, age 40, mechanic, admitted to the University of Chicago Clinics May 2, 1934, complaining of general weakness and presenting a large nodular, slightly tender mass, 12 cm. in diameter, situated in the upper right quadrant of the abdomen and extending to the left across the midline. The mass does not move with respiration and gives the impression of being attached to the posterior abdominal wall. Wassermann and Kahn negative. Uranalysis, negative. R.B.C. 4,140,-000. W.B.C. 7,500. Hb. 61 per cent.

In August, 1932, in another hospital, the right undescended testicle was removed for a malignant tumor. Opportunity was afforded to study the sections made in 1932 of the testicular neoplasm. It is composed of large solid masses of rounded cells with indefinite cytoplasmic outlines (Fig. 1). The nuclei are round or oval, hyperchromatic, and contain one or more nucleoli. There are many mitotic figures. There is very little stroma. Histologic Diagnosis.—Embryonal carcinoma (seminoma) of the testis.

Roentgenograms of the chest show a rounded mass approximately 9 cm. in diameter which stereoscopes in the anterior superior mediastinum (Fig. 2).

Clinical Diagnosis.—Retroperitoneal and mediastinal lymph node metastases from previously removed embryonal carcinoma of the right testicle.

Treatment.—Beginning May 5, 1934, and ending June 8, 1934, the patient received irradiation as indicated in Chart 1. A moderately severe erythema developed on the anterior abdominal port followed by pigmentation and dry scaling. The reaction was

milder on the posterior abdominal port. There was moderate erythema followed by slight pigmentation on the thoracic ports. By the end of June roentgenograms showed
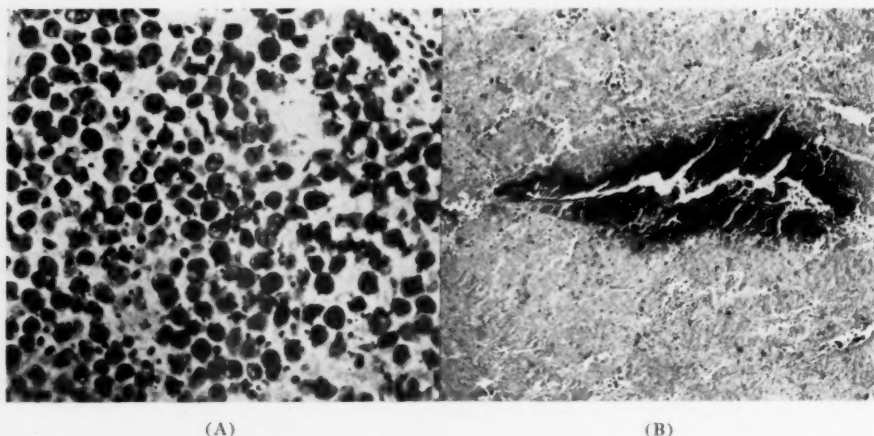

(A)   (B)

FIG. 1.—(A) Photomicrograph ($\times 500$) of section of embryonal carcinoma of right testis removed August, 1932. (B) Photomicrograph ($\times 140$) of section of one or two small necrotic nodules found in the upper retroperitoneal space at necropsy 18 months after irradiation therapy for large metastasis in this region. Only faint "shadows" of tumor cells are seen. The dark mass represents calcification about a necrotic vessel. No viable neoplastic cells are found.

marked regression of the mediastinal mass. The abdominal mass had also decreased about one-third in size.

During August, 1934, the patient's condition continued to improve; there were increased strength, good appetite, no pain and gain of 16 pounds in weight. In Novem-
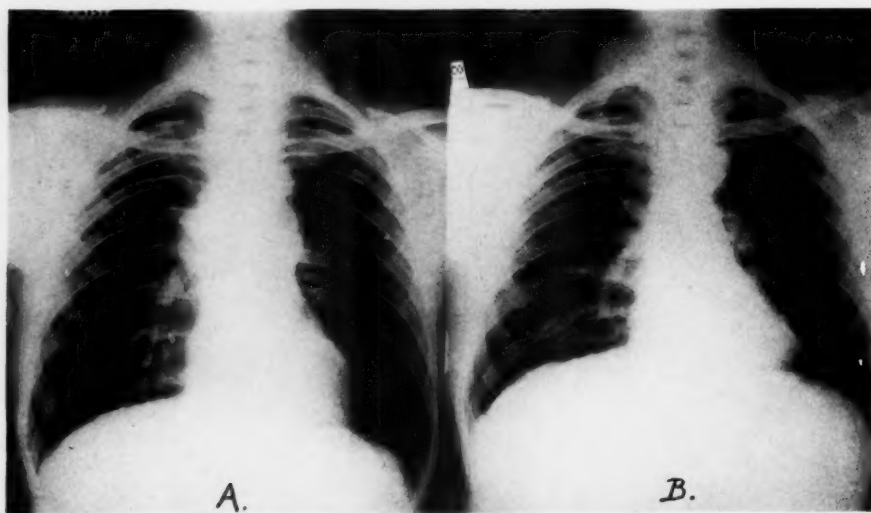

FIG. 2.—(A) Roentgenogram of chest on admission, May 11, 1934, showing large tumor mass in upper mediastinum. (B) Roentgenogram of chest taken November, 1935, showing complete regression of the mass. At necropsy no neoplastic cells, living or necrotic, were found in the mediastinum.

ber, 1934, he complained of severe upper right quadrant pain related to eating. Cholecystograms showed visualization of the gallbladder without stones.

By March, 1935, the abdominal mass could not be palpated and roentgenograms of the chest made in April, 1935, showed complete regression of the mediastinal tumor.

The skin in the anterior abdominal portal was now firm, indurated, leathery and presented small scattered areas of pigmentation and telangiectases.

During the summer and early fall of 1935 there were no complaints. However, on December 16, 1935, the patient was readmitted to the hospital in very poor general condition, complaining of paroxysms of upper abdominal cramps, rhythmic in character, followed by periods of relief. These paroxysms had occurred at intervals for nine days and were sometimes accompanied by vomiting of bile. Examination of the abdomen revealed some distention and generalized tenderness; deep palpation of the upper abdomen was not satisfactory because of the dense sclerosis of the skin in the irradiated field, giving a board like consistency to the abdominal wall. Temperature 98° F. Pulse 100. W.B.C. 20,000. Roentgenograms of the abdomen revealed distention of the small bowel by gas and multiple fluid levels suggestive of low small bowel obstruction.

Clinical Impression.—Obstruction of the small bowel, lower portion probably secondary to recurrence of retroperitoneal metastases.
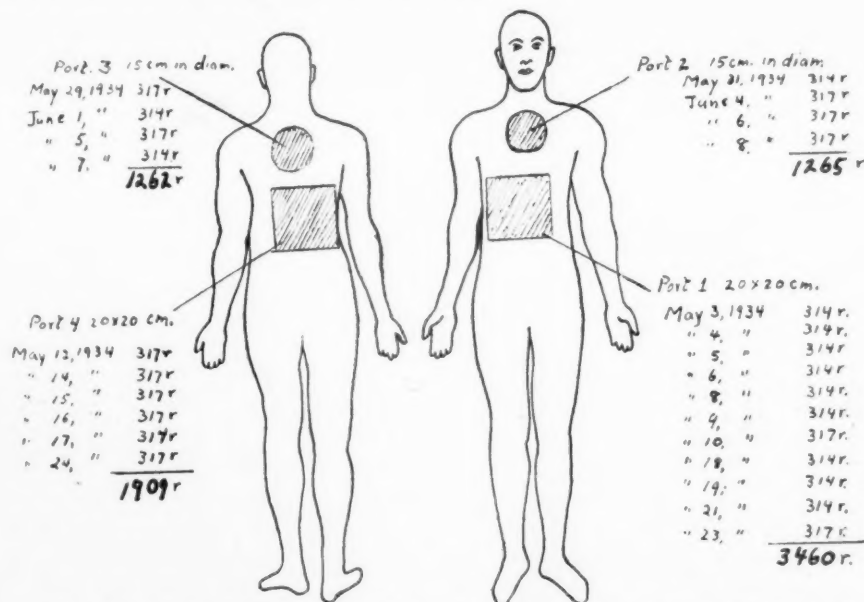

CHART 1.—Detailing amount of roentgen therapy administered in case cited. Factors: 200Kv., 25Ma., F.S.D. 50 cm. Filtration 1¼ Mm. Cu. and 2Mm. A1. Irradiation delivered at approximately 40r per minute. Total period of treatment: 36 days. Estimated "tumor dose" to mediastinal lesion: 1,094r. Estimated "tumor dose" to abdominal lesion: 2,326r.

Operation.—After a brief period of symptomatic improvement due to restricted intake by mouth and hypodermoclyses, the patient was operated upon December 27, 1935, with the intention of relieving the obstruction. The abdomen was entered through a right paramedian incision; retraction of the wound margins was quite difficult because of the dense sclerosis of the skin and subcutaneous tissues. Findings: Diffuse fibrous peritonitis, torsion of a terminal loop of ileum without gangrene but with involvement in a dense mass of adhesions that surrounded the first portion of the transverse colon; gangrene of the segment of transverse colon, three inches long, that was included in the mass of adhesions just described. The torsion of the ileum was reduced and the gangrenous segment of transverse colon lifted easily out of the abdomen. It appeared almost sequestrated from attachments to viable colon on either side. The gaping portions of remaining colon could not be mobilized because of the dense adhesions. The distal segment was invaginated and an ileocolostomy (side-to-side) performed. A glass Paul tube was inserted into the proximal segment and after placing gauze packs about

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it, the abdominal wound was partially closed. The patient died on the sixth day post-operative with clinical signs of generalized peritonitis.

Necropsy.—There was a generalized fibrinopurulent peritonitis, but no evidence of leakage about the ileocolostomy. There was no gross or microscopic evidence of neoplasm in the mediastinum. In the upper retroperitoneal space two small caseous masses 2 cm. in diameter, grossly suggestive of lymph nodes containing necrotic neoplasm, were found. On microscopic examination one proved to consist of a finely granular acellular material; the other was found to be composed of a mass of neoplastic cells which had undergone complete coagulation necrosis, only "shadows" of some of the neoplastic cells remaining with scattered foci of calcification (Fig. 1). No viable tumor cells were found here or elsewhere. Microscopic examination of the necrotic segment of colon removed at operation showed no evidence of neoplasm. The gross and microscopic findings about the site of the removed gangrenous segment of the colon did not indicate that this necrosis was merely the result of a thrombophlebitis. It appeared to be a part of the chronic inflammatory process induced by the irradiation not only in the viscera but in overlying skin and subcutaneous tissues.

DISCUSSION.—The necropsy findings show that the metastatic neoplasms had apparently been controlled by the amount of irradiation administrated. Thus, evidence is presented (one case) to indicate that tumor doses of 1,000 R to 2,400 R, delivered in divided doses over a period not exceeding 36 days and with an intensity of approximately 40 R per minute, might be effective in controlling deeply seated metastases from radiosensitive embryonal carcinoma of the testis. These doses are substantially less than those which experience has shown to be the optimum doses necessary to control squamous cell carcinomata of the buccopharyngeal cavity, *i.e.*, 4,000 R to 4,500 R.

The above patient died of a complication resulting from irradiation, namely, late gangrene of the segment of colon included in the abdominal portals. It is not possible to state exactly the mechanism of production of this gangrene. The history and findings at operation indicate that it was not an acute lesion but was a process that had developed progressively for some time prior to the onset of acute symptoms. In all probability several factors were concerned, namely, a slowly progressing ulceration of the bowel mucosa, a slowly increasing vascular impairment and superimposed upon these a spreading infection from the bowel contents.

It may also be pointed out that the dense sclerosis in the skin and subcutaneous tissues of the anterior abdominal port were well established several months before there was clinical evidence of underlying visceral injury.

Somewhat similar complications in the stomach and ileum have been reported by Elliott and Jenkinson[1] in a patient suffering from abdominal Hodgkins' disease, who received a total surface dose of 2,180 R in nine sessions to the anterior and posterior abdomen over a period of nine months. Seven weeks following the last treatment the patient was hospitalized for abdominal pain which was increased by eating. Exploratory laparotomy was performed at which time peritonitis was observed and an inflamed appendix removed. Five days later the patient died and at necropsy three large and several small ulcers were found in the stomach; the largest of the former, measuring 9 x 12 cm., had perforated. There were also patches of circular

ulceration in the ileum. These authors attribute the ulcerations to the irradiation and not the disease. Jones[2] pointed out that while acute intestinal injuries following irradiation are numerous, the chronic forms appear, until the present at least, to be uncommon. He cited seven known cases of benign stricture of the small bowel from among 520 patients with cervical carcinoma who were treated by local implantation of radium and external roentgen therapy.

One of us (A. B.) has observed a localized severe inflammation in the sigmoid colon adjacent to a chondrosarcoma arising in the region of the left sacro-iliac joint and in the treatment of which approximately 20,000 R (surface dose in air) had been delivered at intervals over a period of 28 months. The symptoms of pain, tenesmus and bloody diarrhea developed 28 months after the onset of treatment and subsided after 16 weeks. The patient is still living five years and two months after beginning treatment and has no marked symptoms referable to this complication. Pressure from the slowly growing chondrosarcoma may have been a contributing factor to the production of the bowel lesion.

It must be emphasized that the outcome in the case reported in detail above should not be construed as indicating that in order to control such neoplasms it is necessary to employ doses that will ultimately prove lethal to the patient. The fatal termination in this instance was due to the fact that this patient belonged to the relatively small group of individuals whose normal tissues do not well tolerate irradiation. Experience has shown that the large majority of patients will tolerate the amounts of irradiation delivered in the case cited without serious difficulty.

SUMMARY

A patient presenting large upper abdominal and mediastinal metastases from a previously removed embryonal carcinoma (seminoma) of the testicle received "tumor doses" of 2,326 R and 1,094 R (roentgen radiation), respectively, to the lesions, over a total period of 36 days. The patient died 18 months later of gangrene of the segment of transverse colon included in the irradiated area of the abdomen due presumably to the irradiation. At necropsy no evidence of neoplasm was found in the mediastinum and only two small masses (2 cm. in diameter) of necrotic neoplastic cells were found in the upper retroperitoneal space. No viable neoplastic cells were found elsewhere.

The unfortunate outcome in this case is explained on the basis that the patient was one of those whose normal tissues do not well tolerate irradiation. Experience has shown that the majority of patients will tolerate, without permanent injury, the doses administered in the case described.

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TISSUE HEATING ACCOMPANYING ELECTROSURGERY

AN EXPERIMENTAL INVESTIGATION

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THE GROWING prevalence of the use of high frequency currents in the resection of excess tissue has led to recent investigations[1] concerning the possible harmful effects of the heat generated by these currents in the vicinity of their application. These investigations have been based upon temperature measurements made with thermocouples inserted into the tissue at the point where dangerous temperatures might be produced and have indicated undesirable heating.

The use of thermocouples for such measurements has possibilities of giving results differing widely from correct values unless certain precautions are taken to avoid spurious heating of the thermocouples themselves. Since previous investigations have not dealt adequately with these difficulties and their elimination, it seemed advisable to determine the magnitude of these errors and to make measurements with the necessary precautions.

The production of the various kinds of high frequency currents and their respective advantages for surgical uses as well as for deep heating by diathermy are ably considered in the literature[4]; that by Hemingway and Senstrom details a convenient and inclusive summary.

Before taking up the discussion of the experimental work it is well to have in mind certain characteristics of the behavior of the high frequency currents in present day surgical use (frequencies from 500,000 to 3,000,000 cycles). We are here interested mainly in their characteristics under certain special conditions: first, the behavior of the currents in the tissues themselves, and, second, the behavior with respect to any foreign bodies that may be present in the tissue—the measuring instrument, for example.

Behavior in Tissue.—The experimental work of McClendon[5] has shown that the cell behaves with respect to the high frequency current as if it were a small bit of salt solution surrounded by a good, but very thin, insulator, the whole immersed in another conducting fluid. This makes the electrical equivalent of the cells immersed in body fluid a circuit of small condensers, shunted by, and in series with, small resistances (Fig. 1).

Since condensers offer great resistance to the passage of electric currents of low frequency and but little resistance to currents of very high frequency, it is natural to expect the body fluids to carry most of the current until the frequency becomes high enough for the small condensers of the cells to allow it to pass. Also, as the frequency increases, the total resistance of the tissue

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should decrease until the resistance of the condensers (reactance) becomes small in comparison with the resistance of the fluids. Then a further increase in frequency should not alter conditions appreciably because the only resistance left is that of the fluids, which is not affected by changes in frequency. The work of McClendon verifies this also.

As has been mentioned before, whenever an electric current flows in a resisting medium, heat is produced. The amount of this heat is proportional to the resistance, to the time the current flows, and to the square of the current density. Christie and Loomis[6] have shown that the heat generated can all be accounted for by considering the electric circuit similar to that mentioned previously. Electrical theory shows that, under the conditions in which the cutting loop is employed, the heating in the tissue should fall approximately as the fourth power of the distance from the loop, for small distances in an homogeneous medium.* The fact that the loop moves with varying speed while cutting and that cutting is done under water in tissues that are nonhomogeneous makes it practically impossible to use the law for
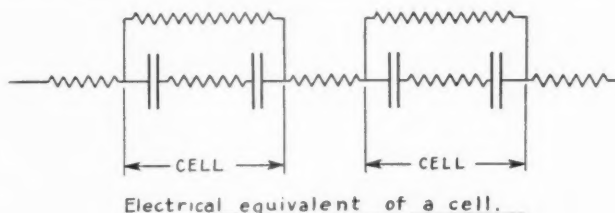

Electrical equivalent of a cell.

FIG. 1.

more than an indication of what to expect. It tells us that, if the temperature rises by one degree at a distance of one centimeter, it ought to increase by 16 degrees at one-half centimeter, 256 degrees at one-fourth centimeter, and so on.

The mention of nonhomogeneity of the medium immediately raises the question as to what paths the current should follow in the body. High frequency currents tend to travel on the surface of good conductors,[7] but Richardson[8] has shown that the body is too poor a conductor for this to take place. The work of Grover[9] shows that the resistances of the various tissues range from dry skin rated at 100 to blood rated at 2, with muscles and glands rated at 20 and 25 respectively. He adds that variations of 300 per cent may be expected when going from individual to individual. However, recent experi-

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* The electrical theory of the current distribution between a small sphere and an infinite plane in an isotropic medium shows that the current density varies inversely as the square of the distance from the center of the sphere for distances small compared to the distance between the sphere and plane. Since the loop is not a sphere nor yet a point electrode, the distribution will not assume the theoretical relation in its immediate vicinity but will approximate it in a small region whose distance from the loop is great enough to overcome the effects of its shape, but not great enough to be beyond the range of the inverse square distribution.

For this reason actual measurements of distribution and time rate of change of temperature were made with a small spherical electrode imbedded in the tissue.

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ments do not verify this great variability. The general conclusion is that currents will tend to avoid fat, bone, and cartilage and, when forced to penetrate these, they will do so with a greater temperature rise. The wise technician will so locate his electrode as to avoid this as much as possible.

However, the variation in resistance between types of tissue should make but little difference in deep heating in a fairly homogeneous medium. In a tissue of greater resistance less current will be needed to raise the temperature at the loop to the cutting point and the heating at a distance will be correspondingly less. This assumes that there is no constant resistance, irrespective of tissue, such as contact resistance at the loop. The doubts relative to the true nature of the mechanism of cutting at the present time indicate that this is a good question for investigation, especially when one considers the fact that currents of equal heating effect, as shown by a thermocouple ammeter, differing widely in spark frequency but not greatly in radio frequency, differ greatly in their cutting ability. In any case the spark frequency is so great that it is impossible for the heating of the cells to follow the changes any better than the ammeter. This leads one to believe that some other phenomena must be involved in the different effects of these currents, a change in power factor for instance.

Effects of Foreign Bodies.—The effects of high frequency currents on foreign bodies, which are of interest here, are two: eddy current heating and electrostatic pick-up.

When currents of high frequency flow around a conductor, they set up currents within the conductor by reason of their magnetic fields. These local currents circulating inside the conductor serve to heat it and in the case of a thermocouple might cause an erroneous reading.

To the person not acquainted with high frequency currents electrostatic pick-up is a most perplexing phenomenon. Those who are accustomed to the ordinary lighting current know that touching one wire of the circuit causes no trouble as long as they are insulated from the other; it is necessary to complete the circuit between the two in order to get a shock. When a person, otherwise insulated, points his finger at the active electrode of a high frequency generator and draws to himself a painful spark, he immediately wonders how that could happen. The explanation is simple.

Any body has what is called electrostatic capacity just as an air tank has what is called air capacity. That is, it requires a certain amount of electricity to charge the body up to a given electric pressure just as it requires a certain amount of air to charge the tank up to a given air pressure. If the air tank in this illustration were a toy balloon and the reader attempted to blow it up and let it collapse once each second, he would soon realize that a good bit of air had passed in and out of his lungs and that he was working rather hard without leaving any great amount of air in the balloon. So it is with high frequency currents. When a body is connected to the active electrode of a high frequency generator, the generator immediately starts to charge it up and discharge it some millions of times each second. It requires a rather large

current to do this, depending, of course, upon the capacity of the body and the rapidity of the changes. This current is the analog of the air flowing in and out of the reader in the previous example and the heat producing the burn is the analog of the work done in keeping the air moving into and out of the balloon.

Also, every body forms one plate of a small condenser with the earth as the other plate and the air between as the dielectric. It will be remembered that condensers offer small resistance to high frequency currents. Thus some of the current to the body is flowing through this condenser.

From the foregoing it is evident that the foreign bodies introduced into the tissue to measure the temperature may be warmed by eddy currents set up
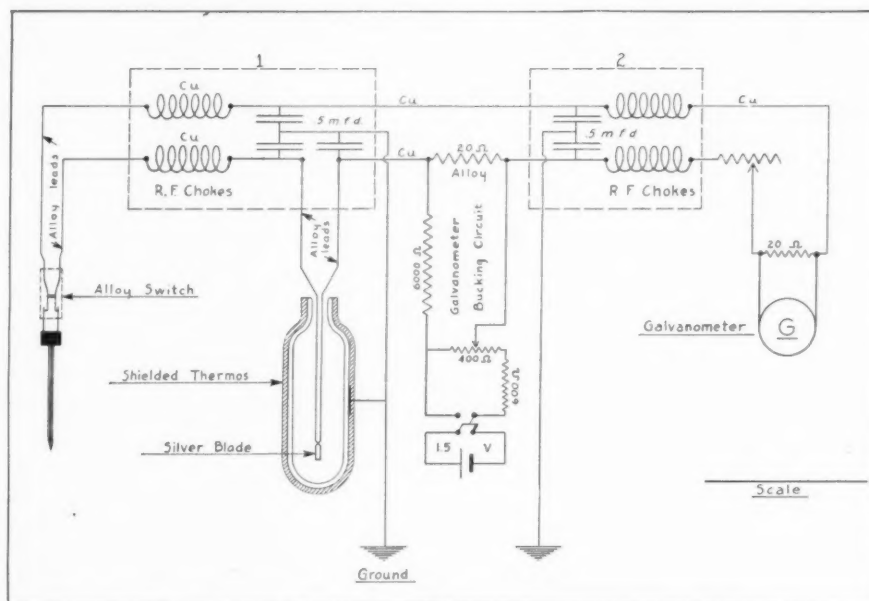

Fig. 2.—Schematic diagram of temperature measuring equipment.

within them or by the current they draw to themselves by reason of their electrostatic capacity and that of the apparatus to which they are attached. These effects have been investigated in detail.

DESCRIPTION OF APPARATUS.—*Measuring Circuit.*—The temperature measuring circuit was the usual set up for measuring temperature by means of thermocouples, with certain modifications as necessity demanded. The circuit as finally used is shown in Fig. 2. The chokes and condensers within the dotted areas 1 and 2 served to block the high frequency current from parts of the apparatus where it was not wanted.

Thermocouples.—The thermocouples used for measuring the temperatures consisted of two strands of No. 28 wire, one of alumel and the other of chromel, run through a pyrex tube 2 Mm. in diameter and 10 cm. long (Fig. 3A). The two wires were insulated by encasing one of them in a tiny pyrex
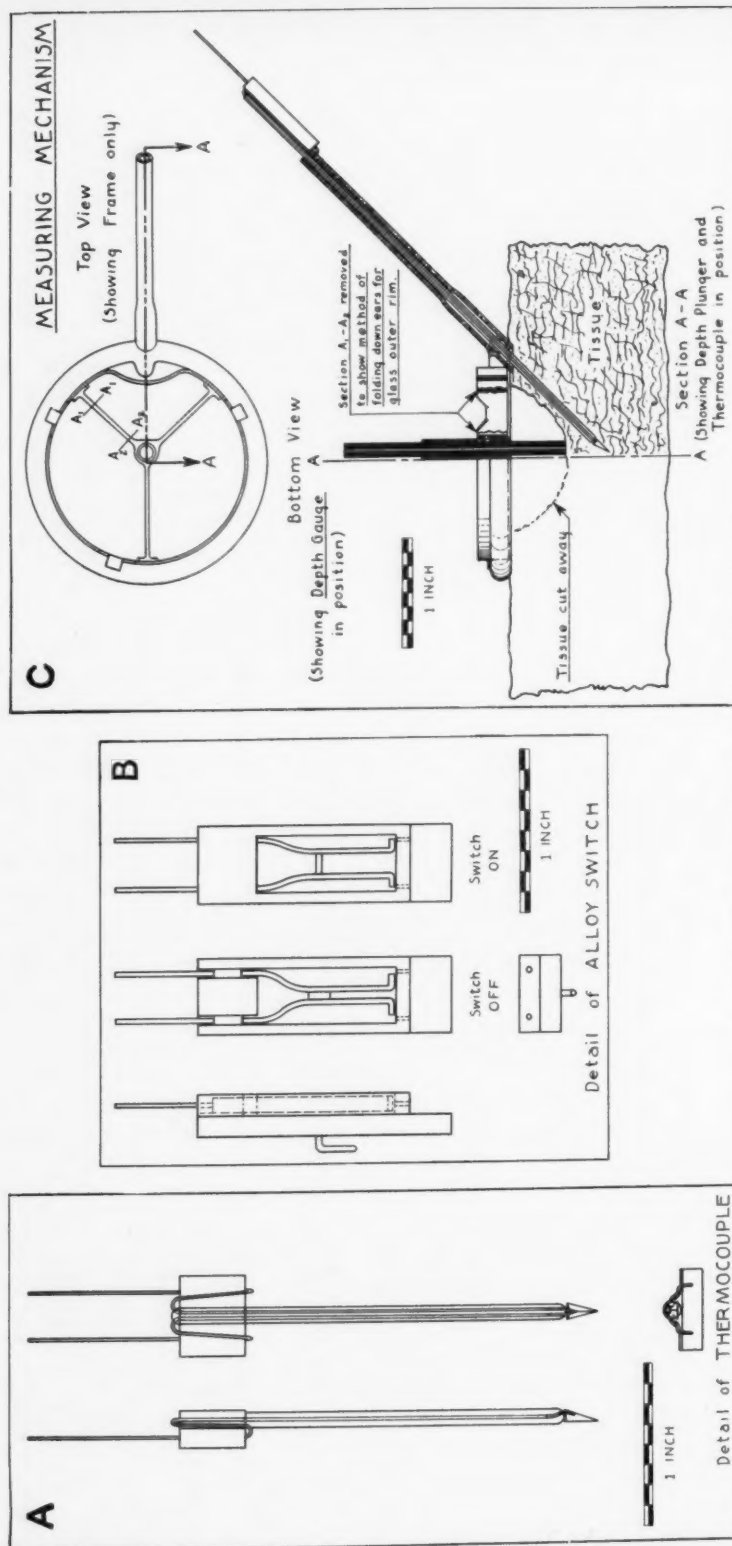
Fig. 3.—Thermocouple construction, connection, and location.

sleeve just large enough to slide over the wire. The outer tube was then collapsed upon the leads by heating. This left a stem $1\frac{1}{2}$ Mm. in diameter with the wires sealed in. The junction was made by fusing the two wires and then silver soldering to the various tips as mentioned later. The leads were spot welded to No. 22 wire of the same alloy anchored in a small hard rubber plug. This was made to fit into an all-alloy low capacity switch as shown in Fig. 3B. The cold junction was made in the same manner but with larger tubing and the tip was silver soldered to a silver blade 5 by 8 by $\frac{1}{2}$ Mm. for reasons mentioned later. The cooling bath was a pint Dewar flask.

Chokes.—The chokes were of the pie-wound low loss type and proved quite effective on the vacuum tube current but much less so on the spark current.

Measuring Gauge.—Probing was found to be very unsuccessful in determining distances to the couples from the cut surface thereby necessitating a measuring gauge (Fig. 3C). A pyrex ring 5 cm. in diameter with a slanting tube sealed to one side to serve as a guide for the couple was constructed as shown. The depth gauge for use in determining the distance from cut to couple tip was so constructed as to use the glass ring for a measuring base. In use the ring was held firmly on the surface of the tissue and the couple inserted through the guide tube. The tissue was then cut away as shown in Fig. 3C by making progressive cuts across a plane parallel to that of the ring. To gauge the distance to the couple it was only necessary to snap the depth gauge onto the ring and make the measurement by obtaining the distance to the cut surface and subtracting from the known distance to the couple. In the following data the distance from the couple in a series of cuts always means the shortest distance from the couple to the plane of the series of cuts. The error in measuring distances under 1 cm. is about 10 per cent. This is due to the distortion of the tissues during the cut, their subsequent slight compression during measurement, and to the length of the tip. The gauge readings are accurate to $\frac{1}{4}$ Mm. Even this considerable error is a large improvement over the errors introduced by the displacement of couple and tissue when searching with a probe.

STUDY OF ERRORS.—The following errors that may arise in using an apparatus of this sort, when used as shown in Fig. 2, were investigated. The occurrence of each error and the means of elimination when necessary are shown for each case as it is discussed.

Stray Electromotive Forces.—Whenever two dissimilar metals meet in the circuit there will be an electromotive force set up that will vary with any change in temperature at that point. They are in effect additional thermocouples. Since we are using the apparatus to measure temperature differences only, it is not necessary to avoid long time changes of these electromotive forces. So long as they do not vary while a single temperature difference is being measured they can be disregarded. With the couples inserted in constant temperature baths, the instrument was watched for any change. None of detectable value was observed in the length of time required to measure

the temperatures desired. Nor was there any measurable effect when the high frequency generator was used in the immediate vicinity of the equipment. The alloy switch mentioned earlier prevents errors arising from the heat of the hands.

Heat Capacity of Couples.—In view of the rather poor heat conductivity of tissue it is possible that the heat capacity of the tip may cause its temperature to lag behind that in the tissue. The low specific heat of the materials involved makes this seem unlikely. By experiment it is found that the time required for the galvanometer to reach equilibrium is the same when the couple is connected to it before inserting into the tissue as when the couple is connected after being in the tissue for some time. This would not be the case if the couple were lagging in temperature.

Galvanometer Lag.—The period of the galvanometer used was 4.5 seconds on open circuit. When connected to its critical damping resistance six to seven seconds were required for the instrument to indicate the reading after connection to a couple already in equilibrium with its surroundings. The sudden temperature changes found when working within about 3 Mm. of the cutting loop are such that the instrument is unable to follow them. The cooling of the tissues before a reading is indicated would make it considerably low. Since a galvanometer capable of following the rapid changes was not available, the experimental work was confined to regions where this error would not be appreciable.

Heat Used by Thermocouple.—The electric current generated by a thermocouple arises at the expense of heat absorbed at the junction of the metals. A computation, based on Bridgeman's[10] thermodynamic analysis of thermocouples shows that the temperature gradient necessary to supply this heat is negligible. This is verified by the fact that couples with tips of different sizes indicate the same temperature in the tissue.
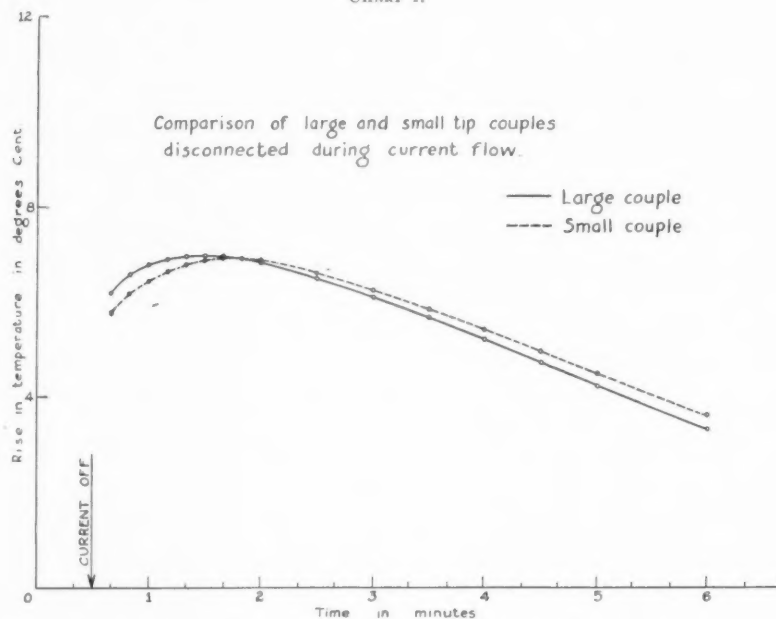
Suspension Distortion.—The most desirable method of studying the temperature change during a cutting series is to have the measuring circuit connected at all times during the work. It was found that, for galvanometer deflections of 30 to 40 cm., the suspension became permanently twisted. The twist increased with time, amounting to about 0.6 cm. in the course of 30 minutes. The bucking circuit was arranged as shown in Fig. 2 in order to allow the cold junction to be held at zero degrees and always have the galvanometer start from zero for a set of readings. A series of tests showed that the distortions on the small displacements encountered when used thus were of no significance.

Eddy Current Heating.—Thermocouples with tips of assorted sizes ranging from a pair of twisted No. 28 wires 2 Mm. long to a brass plug 5 by 10 Mm. were inserted into the same spot in a piece of beef. Couples were disconnected while current was flowing. The size of tip made no difference greater than the experimental error of .2° as determined by check runs to find the effect of withdrawal and insertion of the couples. Data were taken also for the strong fields in the neighborhood of an 8 Mm. brass sphere elec-

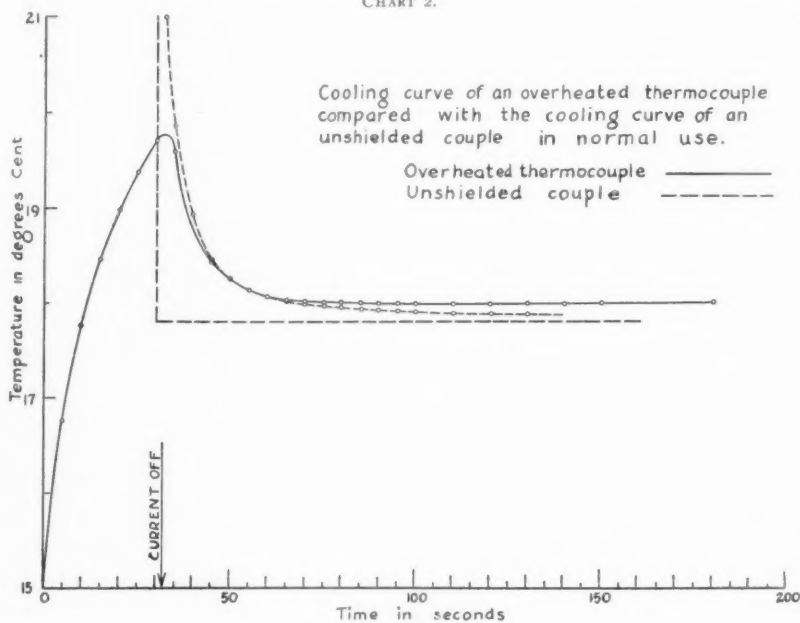trode with a necessarily reduced range of tip sizes.   Chart I shows a typical comparison.

CHART I.

Comparison of large and small tip couples
disconnected during current flow.

———— Large couple
- - - - Small couple

Stem Conduction.—The study of Bazett and McGlone[11] shows that even with their all metal couples the conduction would vary but little over the range of temperatures herein encountered.   A constant value would cancel for

CHART 2.

Cooling curve of an overheated thermocouple
compared   with the cooling curve of an
unshielded couple   in normal use.

Overheated thermocouple ————
Unshielded   couple   - - - - - -

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a difference measurement. The glass stems used in this work would minimize any error. Experiment shows that the size of the tip does not alter the reading as it should if conduction were important.

Electrostatic Pick-Up.—This proved to be the most fertile source of error and by far the hardest to overcome. The connection of the couple to the associated measuring apparatus gives it considerable electrostatic capacity. Hence it will draw current from the tissue as was explained in the beginning of the article. When the current flows through the tissue to the couple, heat is evolved, and the result is a locally heated spot surrounding the tip. Chart 2 shows the temperature indicated by a thermocouple whose tip was a pair of No. 28 wires fused at the end, which projected 2 Mm. from the glass stem.

CHART 3.
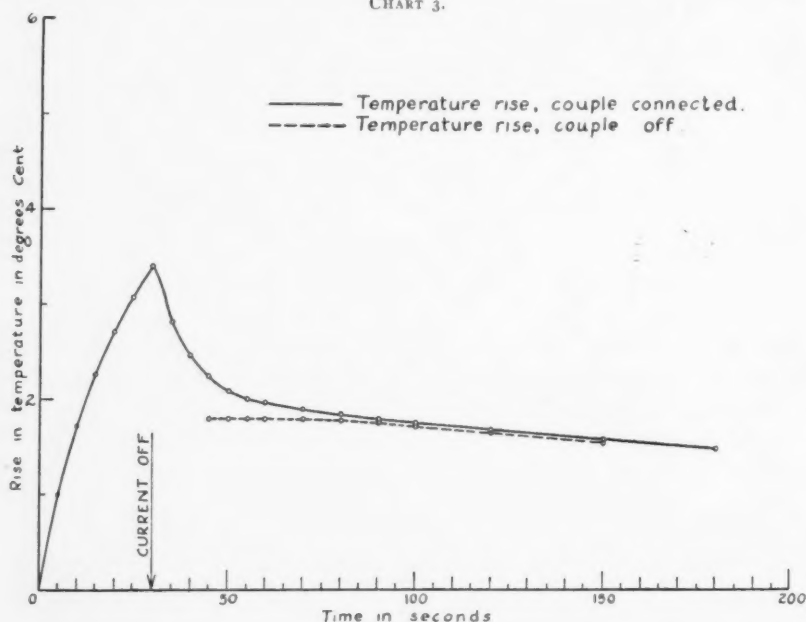
It was located midway between two copper electrodes 6 by 2 cm., 10 cm. apart, in beefsteak and was connected to the apparatus during the current flow.

Examination of the curve shows that the couple must be overheating. The slow cooling rate after the first 50 seconds is entirely inconsistent with the rapid drop in the 25 seconds following the interruption of the current. The choke coils shown in Fig. 2 offer an extremely great resistance to the passage of high frequency current and should nullify the effects of the capacity of the apparatus connected to them.

In order to make doubly sure that this was an overheated couple, the tip was heated while in the meat by passing some current from the house mains down one lead and up the other. This served to heat only the couple and the meat in direct connection with it. The broken curve in Chart 2 is the cooling curve of this overheated couple, with its axes shifted so as to compare with

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the cooling of the supposedly overheated couple. The agreement removes all doubt concerning the overheating. These curves have all been repeated under different conditions with the same results, thus eliminating the possibility of chance agreement.

The slow cooling as shown by the tail of the heavy curve in Chart 2 indicates that there ought to be time to connect the couple to the circuit after turning the current off without introducing appreciable error. Chart 3 shows the temperatures indicated by the couple when connected and when disconnected during period of current flow but under otherwise identical conditions.

At first glance it would seem that the chokes ought to prevent the overheating by stopping the pick-up. There are two factors that prevent this.

CHART 4.
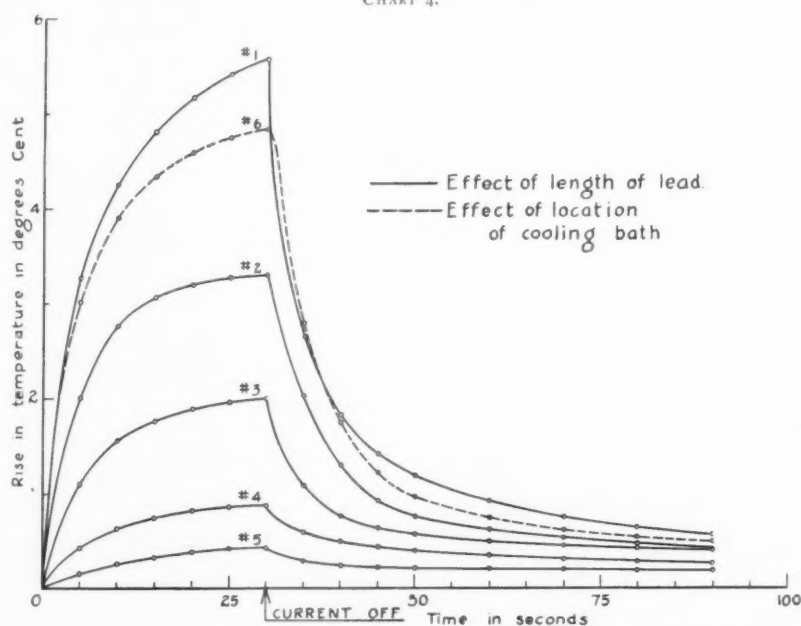
First, there is the capacity of the wires leading up to the chokes and second, there is the capacity of the chokes themselves. The first can be cut by using short leads and the second can be minimized by using low loss chokes. Neither can be entirely eliminated, however.

The effect of length of leads from couple to chokes is shown in Chart 4. The upper curve was obtained with four feet of two strand No. 24 enameled copper wire. The lower solid curves were obtained by successively shortening the leads in steps of one foot until only the usual 14 inch lengths of alloy wire remained. The current in this case was 1.5 amperes between two 3 cm. square electrodes 10 cm. apart. The couple was not inserted in the field of the current but 10 cm. on the other side of the active plate, thus 20 cm. in all from the ground electrode. In this location, as was found by experiment, the
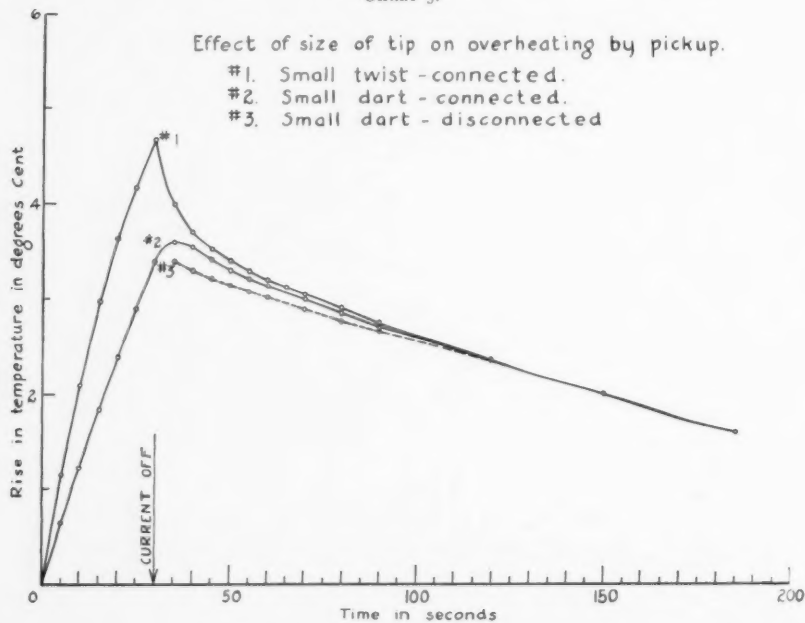
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high frequency did not heat the tissue appreciably. Any temperature rise was due almost entirely to pick-up.

The broken curve No. 6 on Chart 4 was obtained under the same conditions as curve No. 5 but with the cooling bath moved to the high potential side of the chokes as indicated in the article by Caulk and Harris.

Repeating the work as outlined for Chart 4 but with the couple in the current stream gave similar results partly masked by the actual heating of the tissue.

The error of the cooling bath is due to the conductivity of the ice water used and to the silver coating of the bottle. Using an open flask of water still gave capacity effects thereby indicating the part played by the cool-

CHART 5.

Effect of size of tip on overheating by pickup.
#1. Small twist-connected.
#2. Small dart-connected.
#3. Small dart-disconnected

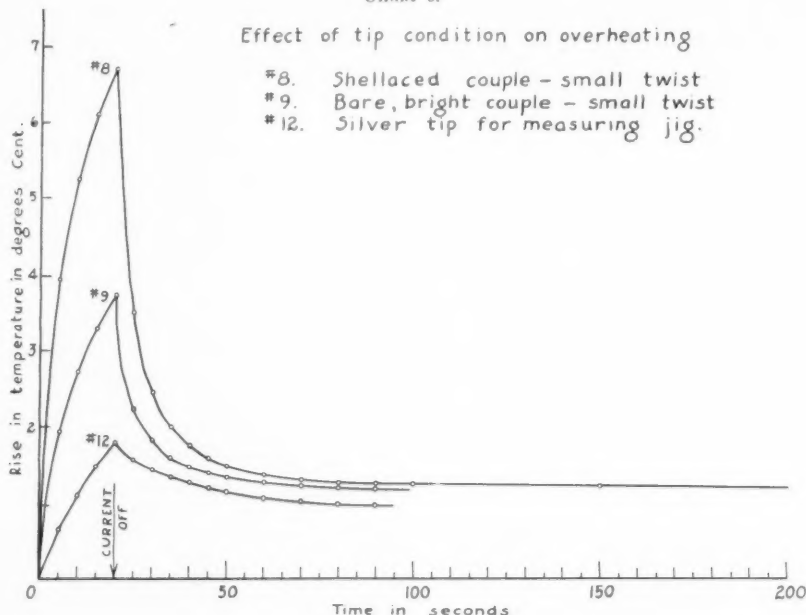Rise in temperature in degrees Cent

CURRENT OFF

Time in seconds

ing water. The current fed from the thermocouple to the cooling bath served to overheat it and thus neutralize some of the error from the overheating of the measuring couple. This would seem to be a good method of combating the overheating of the measuring couple, but there is no way of being sure that a balance established for one spot of tissue will be maintained for others. The addition of the silver blade mentioned previously to the cold junction served to greatly reduce the overheating and the shielding of the cooling bottle completely stopped it.

Since it was not possible to eliminate pick-up completely, save by disconnecting the couple, it became necessary to minimize its effects. This was accomplished by increasing the surface at the tip of the thermocouple by attaching thereto a small silver dart. The increased surface reduced the heating by reducing the density of the picked-up current and by giving more area

for heat dissipation. The effect of the size of the tip on the overheating is shown in Chart 5. The addition of a small flat silver arrow tip of about 3 sq. Mm. total surface almost neutralizes the error. In any case it is always possible to check against overheating by leaving the couple disconnected during a repetition.

In the work of Caulk and Harris[12] the tips of the couples were coated with shellac. Chart 6 shows the effect of a coating of shellac upon a small tipped couple (couple tip without silver dart). It is quite evident that the addition of the shellac increases the overheating error. The couple leads were increased in order to give some pick-up to demonstrate the difference. This

CHART 6.

Effect of tip condition on overheating

#8. Shellaced couple – small twist
#9. Bare, bright couple – small twist
#12. Silver tip for measuring jig.

accounts for the evident overheating of the silver tipped couple (curve No. 12) but is further evidence that the tip decreases the overheating.

Further, in the work of Caulk and Harris the couple tips were smaller than the smallest used for the above work, the leads were about 30 inches long, the cooling bath was on the high potential side of the chokes, and the couples were connected to the chokes while the current was flowing. In view of the demonstrated consequences of each of these changes it seems entirely possible that previous measurements may have been considerably in error. Therefore the following experiments were run to determine the temperatures generated by the high frequency currents. Every precaution was taken to eliminate the above errors.

TEMPERATURE DETERMINATIONS.—In this work the thermocouples were checked daily against two standard thermometers. The galvanometer circuit was so adjusted as to read 1° C. per cm. of deflection. Because of the neces-

sary error in measuring distances to cuts, and the error in timing strokes, 5 per cent was considered sufficient accuracy for temperature measurements. A consideration of the possible errors of temperature measurement indicates that they were in all probability within this amount except on the small temperature changes of a few tenths of a degree.

Cutting was done with a Stern-McCarthy loop and the duration of strokes was measured with a metronome. Coagulation currents were applied with the same loop. A previous study indicated that the deep heating effects were the same for spark and vacuum tube currents of equal magnitude as indicated by the thermocouple ammeter used in this work. This allowed the use of vacuum tube current for cutting measurements which was advantageous, because the couple could be left connected.* Coagulation currents were drawn from a spark generator and effects were measured by the disconnected couple method.

Table I shows how the temperature rises for a series of three second cuts spaced ten seconds apart. The series of cuts served to cut a small hollow in the piece of beef. The distance given is the distance from the bottom of the trough to the thermocouple which was centered under it. The top of the section cut away was an area about 3 cm. by 2 cm. Fig. 3C shows how the cutting was done. This was intended to duplicate the temperatures as they would occur in electrical resection of a prostate gland. The dead tissue cools very slowly and the cuts were made more frequently than would actually be the case in an operation. Thus these temperatures ought to be higher than would actually be found. Each line of the table represents work on a different spot in the beef.

TABLE I

CUTTING UNDER WATER

Number of 3 sec. Cuts. Spaced in 10 sec.	Distance from Bottom of Trough to Couple	Current	Temp. Rise C.
14	6 Mm.	600 Ma.	4.1° C.
14	7 Mm.	600 Ma.	4.5° C.
10	5 Mm.	600 Ma.	4.5° C.
12	5 Mm.	600 Ma.	5.3° C.
14	3 Mm.	600 Ma.	5.0° C.
15	3 Mm.	600 Ma.	5.8° C.
15	3 Mm.	650 Ma.	4.9° C. (Better cooling)
13	4 Mm.	650 Ma.	4.7° C.
15	4 Mm.	600 Ma.	5.2° C.
14	11 Mm.	600 Ma.	.9° C.
7	8 Mm.	600 Ma.	1.0° C.

In Table II the same procedure was followed. In this case, however, a temperature reading was taken as soon as each layer of strokes had been completed. The distance in each case is that from the plane of the strokes to the

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* Because of the single frequency of the vacuum tube generator the current can be more effectively excluded from the measuring circuit than is possible when working with a spark generator.

couple. The area of the plane is as stated before. However, as the trough deepens the area becomes less, thus decreasing the number of strokes per layer. Table II is a typical one taken from several trials all of which agreed well. The work here is done under water. The temperature given is the total temperature since the start of the whole table.

TABLE II

3 SEC. CUTS WITH 650 TO 700 MA. SPACED 10 SEC. APART
COUPLE CONNECTED

6 cuts to within 1.8 cm. gives a temp. of 0.3° C.
3 cuts to within 1.2 cm. gives a temp. of 0.5° C.
3 cuts to within 1.0 cm. gives a temp. of 1.1° C.
3 cuts to within .8 cm. gives a temp. of 3.1° C.
2 cuts to within .5 cm. gives a temp. of 4.6° C.

Table III is the same as Table II but the spark current was used with the couple disconnected.

TABLE III

SPARK CURRENT 800 MA. CUTS SPACED 10 SEC.
CUTTING ON VEAL

7 cuts of 3   sec. to within 2.3 cm. gives 0.5° C.
7 cuts of 3   sec. to within 1.7 cm. gives 1.2° C.
7 cuts of 2½ sec. to within 1.1 cm. gives 3.2° C.
6 cuts of 3   sec. to within .5 cm. gives 8.7° C.

Table IV gives the results of work on three different beef hearts. In this case water at 25° C. was flowing on the cut surface. The cuts were of 2 sec. duration spaced at 20 seconds. This was an attempt to duplicate the work resulting in Table IV of the article by Caulk and Harris.[1]

TABLE IV

Number of Cuts	Temp. Rise° C.	Current	Distance to Plane	Remarks
7	0.4° C.	550 Ma.	1.9 cm.	Conduction in 2 min. to 1.0
8	0.8° C.	700 Ma.	1.9 cm.	Conduction in 1.1 in 90 sec.
8	0.5° C.	500 Ma.	1.6 cm.	
5	0.6° C.	700 Ma.	1.6 cm.	
7	0.9° C.	500 Ma.	1.4 cm.	
7	0.7° C.	500 Ma.	1.4 cm.	
7	1.3° C.	900 Ma.	1.4 cm.	
6	0.6° C.	700 Ma.	1.3 cm.	
7	1.0° C.	500 Ma.	1.0 cm.	
6	1.1° C.	900 Ma.	1.0 cm.	
6	1.7° C.	700 Ma.	0.8 cm.	
3	0.8° C.	500 Ma.	0.7 cm.	
5	2.0° C.	500 Ma.	0.6 cm.	
1	2.0° C.	900 Ma.	0.6 cm.	

TABLE IV—*Continued*

1	1.3° C.	500 Ma.	0.5 cm.	Difference due to spread of
4	2.6° C.	500 Ma.	0.5 cm.	plane of three cuts
1	3.5° C.	500 Ma.	0.3 cm.	Two trials identical

A comparison of Table IV with Table IV by Caulk and Harris for similar work shows differences of from 300 to 800 per cent.

Temperature determinations were also made on the spark coagulating currents. As would be expected, the heating for a given current is considerably greater because the loop is not moved but left in one place. These following coagulation temperatures were made with the regular No. 12 loop held on edge against the tissue.

Table V shows the typical time of application of coagulating current as observed in an actual prostatic resection.

TABLE V

COAGULATING CURRENT APPLICATIONS

Time in Seconds	0 to .4	.5 to .9	1.0 to 1.9	2.0 to 2.4	2.5 to 2.9	3.0 to 3.4	3.5 to 3.9	4.0 to 4.4	4.5 to 4.9	5.0 to 5.4
Number of Applications	12	42	34	16	7	1	2	1	0	1

As can be seen, most applications are in the neighborhood of one second. In the above resection all applications longer than one and one-half seconds were made with the loop in motion.

TABLE VI

COAGULATION CURRENTS

Distance	Time	Temperature	Current
1.9 cm.	10 sec.	0.5 °C.	700 Ma.
1.7 cm.	10 sec.	1 6 °C.	690 Ma.
1.6 cm.	10 sec.	1.6 °C.	700 Ma.
1.6 cm.	5 sec.	0.35° C. three trials	600 Ma.
1.3 cm.	10 sec.	2.0 °C.	690 Ma.
0.9 cm.	10 sec.	6.5 °C.	700 Ma.
0.95 cm.	5 sec.	2.9 °C.	600 Ma.
0.8 cm.	5 sec.	8.7 °C.	600 Ma.
0.7 cm.	5 sec.	11.6 °C.	690 Ma.

Table VI shows the data from two different days on two different beef hearts. The applications were done under water with running water circulating over the loop. It will be noted that the applications were for either five or ten seconds. The loop was not moved. As a result, it cut into the tissue somewhat and at the end of the application was closer to the couples by about 1 Mm. for a 5-sec. application and about 2 Mm. for a 10-sec. one. The distances listed are the initial ones before the application was made. Since

the galvanometer lag introduced considerable error on the rapid temperature
changes at distances less than those given, it was found necessary to get infor-
mation on them in another manner.

If a piece of muscle tissue is treated with the coagulating current in the
above manner and then cross-sectioned with a scalpel, a peculiar white ring is
found surrounding the burned spot in contact with the loop. The sharp defi-
nition of the edge of the white ring suggested that perhaps the tissue turned
color at a quite definite temperature. By soldering a flat plate of silver to a
thermocouple and placing it upon a fresh cut surface of a piece of the muscle,
it was easily possible to determine the temperature at which this change took
place. The plate was heated by the radio current just as any other electrode
would be. Since the temperature at the plate is higher than at any other
point, it was only necessary to find the temperature that just whitened the
tissue in contact with the plate.

A temperature of 50° C. for a minute produced no visible effect. A
minute at 62° C. gave a very faint whitening and 5 sec. at 70° C. gave a thin
but definite white layer. This places the probable temperature transition point
as 65° C. ± 5° C. Doyen[13] gives 65° C.

Table VII shows the extent of this destruction when using a No. 12 loop
on edge when under flowing water. The loop was pressed firmly on the tissue
but all sparking was not eliminated. The initial temperature of the heart
was 20° C. The outer boundary of the white is assumed as 65° C. This
means a rise of 45° C. at the distance to the edge of the ring. Since the loop
is constantly progressing nearer and nearer to the couple, while the current is
applied, it is not possible to assign any definite distance to the application.

TABLE VII

Time	Current	a		b	c	d	e	f	Power Set
5 sec.	850 Ma.	6	Mm.	4½	1½	3	7	3	90
4 sec.	850 Ma.	5	Mm.	3½	1½	2½	6	2½	90
3 sec.	850 Ma.	4½	Mm.	3	1½	2½	5	2	90
2 sec.	850 Ma.	4	Mm.	2½	1½	2	4½	1½	90
1 sec.	850 Ma.	3	Mm.	1¾	1¼	1½	3½	1¼	90
5 sec.	650 Ma.	5	Mm.	4	1	3	5	2½	45
4 sec.	650 Ma.	5	Mm.	4	1	3	4½	2¼	45
3 sec.	650 Ma.	4	Mm.	3	1	2	4	2	45
2 sec.	650 Ma.	3½	Mm.	2½	1	1½	3½	1⅛	45
1 sec.	650 Ma.	2½	Mm.	1¾	¾	¾	2½	1	45
5 sec.	400 Ma.	3	Mm.	2	1	1	4	1½	22
4 sec.	400 Ma.	2½	Mm.	1¾	¾	¾	3	1	22
3 sec.	400 Ma.	2	Mm.	1¼	¾	½	3	1	22
2 sec.	400 Ma.	1¾	Mm.	1¼	½	½	2	¾	22
1 sec.	400 Ma.	1¼	Mm.	⅞	⅓	½	1½	½	22

For the significance of a, b, c, d, e, f refer to Figure 4.
a, b—Depth of bottom of white ring and bottom of burned area respectively.
c—Radial thickness of white ring.
d—Depth of wire from surface after current application.
e, f—Horizontal diameter of white ring and burned area respectively.

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The constant radius of the white ring shows that the fourth power law should be valid for these distances. If temperatures of a locality between the measured values listed and those determined by the white ring are desired, an application of the fourth power law based on the white ring temperatures and also based on the measured values farther out will give the limits within which the temperature at the point in question lies.

The average coagulation current as measured in the actual resection was about 650 Ma. The applications were of the order of one second. A study of the above table shows about what to expect from such an application. In Fig. 4 the shaded area represents the charred tissue and the light shading represents the white ring used as a temperature indicator.

In order to show as closely as possible the difference between this work and the previous study, an attempt was made to duplicate as nearly as possible
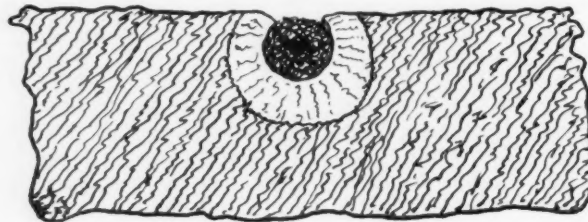
FIG. 4.—The shaded area represents the charred tissue, the light shading represents the white ring used as a temperature indicator.

the experiment of Caulk and Harris with a button electrode on a rabbit leg muscle. The measurements were made with the same size of electrode (Table VIII).

TABLE VIII

Distance	Current	Temp. Rise	Time	Previous Current	Previous Temp. Rise
1 cm.	1200 Ma.	1.9° C.	3	1000 Ma.	9.86° C.
1 cm.	1200 Ma.	1.6° C.	3	1000 Ma.	10.46° C.
1 cm.	1150 Ma.	1.6° C.	3	1000 Ma.	11.32° C.
1 cm.	850 Ma.	.0° C.	4	. . . .	. . . . .

The cooling by the blood stream in a matter of a few seconds is not large in a muscle. It took some three minutes for the temperature to fall back to normal from the two degree rise indicated above. A further study of Table XI in the report of Caulk and Harris shows that a 6 sec. heating does not give double the temperature of the 3 sec. heating by a great deal. The difference is larger than can be accounted for by blood cooling. However, from the experience of overheating the couples in order to make the comparisons mentioned previously, it was found that the overheating of the couple is most rapid at the start and soon reaches a point of equilibrium where the picked-up current is just sufficient to maintain the excess temperature. This would account for the difference in the temperature rises in equal intervals of time.

The results of these experiments show, quite plainly, the possibility of

very considerable errors in the use of thermocouples in the presence of high frequency currents and give no evidence of undesirably high temperatures when due precautions are observed.

Further, a comparison with the work of Caulk and Harris, as previously indicated from time to time, shows large differences under similar situations. Differences at times are as large as 800 per cent. They conclude as a result of their measurements: "In using the various high frequency cutting instruments tissue damage is often produced more deeply than is generally desirable and is often to some extent unavoidable. High current densities applied for more than a second or two may do damage at depths from a few millimeters to over a centimeter." Since the duration of individual cutting strokes during a resection is about three seconds it is doubtful whether most careful application would avoid frequent deep damage with ensuing necrosis and sloughing if the foregoing conclusions are true.

The results of 400 prostatic resections performed with high frequency currents as reported by Alcock[2] do not bear out these conclusions. There are, as pointed out in the clinical findings, indications of sloughing and necrosis following resection, but not of a magnitude consistent with the findings of Caulk and Harris.

The conclusions drawn regarding the destruction caused by the heating effect of high frequency currents are based, of course, on the experimental determination of the thermal death point of cells. The work of Pincus and Fischer[3] indicates that a rise of $10°$ C. maintained for 30 minutes has no apparent effect and that a temperature of $13°$ C. above normal can be withstood for two to three minutes with growth inhibition but without death. Charges in excess of this are almost surely lethal. These measurements were made on isolated cells grown in culture. It seems reasonable to believe that cells in the living organism with normal surroundings could withstand more violent treatment. Thus an estimate of $11°$ C., irrespective of shortness of duration, as the thermal death point of cells is quite conservative.

The experiments of Caulk and Harris show temperatures well in excess of these values in several instances. Our results indicate a temperature rise of about $4°$ C. at a distance of 0.5 cm. following a considerably abnormal sequence of cutting strokes. Temperature changes are correspondingly less at greater distances.

Theoretical consideration of the cooling curve shown by Caulk and Harris in their article gives further evidence of the existence of uncorrected errors in their measurements. When working with small fixed electrodes, such as a small sphere imbedded in the tissue, the error of a moving loop is eliminated. In a part of their work this was done. They give a typical heating and cooling curve which is represented in Chart 7.

The rise in temperature to the first peak is interpreted as the heat of the current. When the current is stopped, the tissue then cools to a temperature as at A and then rises to a peak at B (Chart 7) when the wave of conducted heat reaches the couple from the hotter regions nearer the electrode.

Suppose the heat generated varies inversely as some power greater than the first of the distance from the electrode. If the specific heat stays constant, the temperature will also vary in the same manner. The heat and temperature curve should look as represented in Chart 8 at a given instant.

Suppose the couple is located at such a distance that the temperature is

CHART 7.
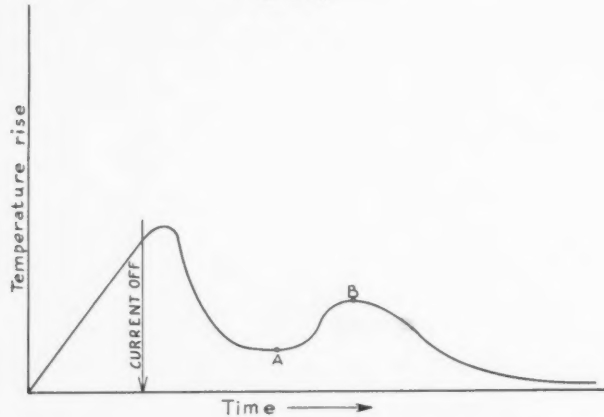
indicated by the point Q. If we were to examine the temperature a little closer to the electrode, say a distance S_1, we would find that the temperature was greater by an amount T_1. If we went an equal distance in the opposite direction from the arrow, we should find that the temperature was lower by an amount T_2. Further, since the variation of temperature is not a strict

CHART 8.
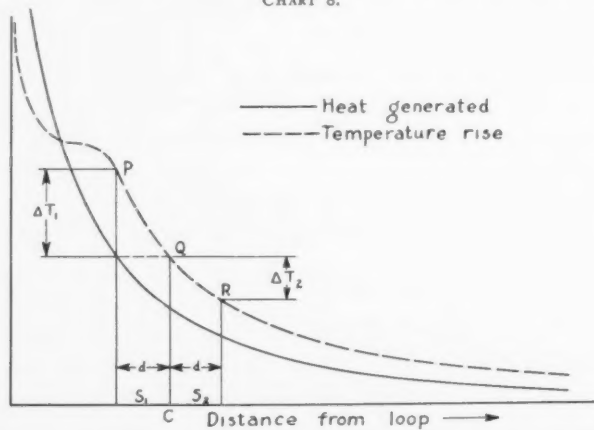
inverse proportion but varies inversely to some power between the second and fourth (Chart 9) with distance, because of the peculiarity of the set up, T_1 will be greater than T_2. This can readily be seen on the Chart. If T_1 is greater than T_2, more heat will flow from the hot regions to the couple than from the couple to the cooler regions. Thus when the current is turned off, the temperature should rise or perhaps hold nearly constant, but it could

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not fall and then rise again. Once it starts to fall it must continue to do so. To get a curve such as is shown by Caulk and Harris the couple would have to be overheated so that it was warmer than the surrounding tissue.

Chart 9 shows the results of a study of the heating around a ball electrode with a couple whose overheating did not exceed 0.2° C. It will be noted that the temperature rises slightly or holds constant for a time after the current is stopped but does not drop and rise again. This evidence of overheating of the thermocouple in the work of Caulk and Harris points to those errors which tend to overheat the couple as the most likely ones.

CHART 9.

Comparison of heating as a function of distance from ¾ cm ball electrode.
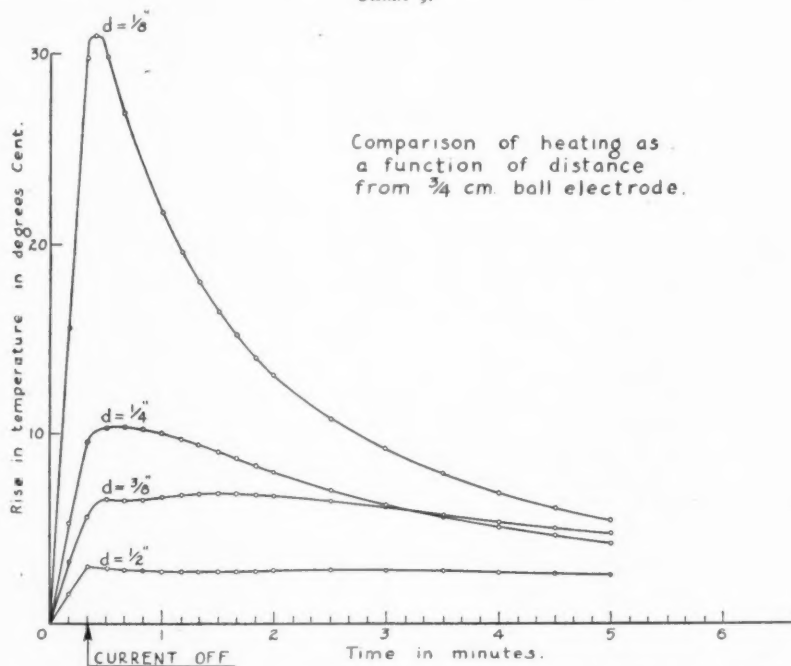
The flat portion of the dotted temperature curve of Chart 8 is interesting. It is due to the heat of vaporization of the water content of the cells. It requires about seven to eight times the amount of heat to evaporate the water after reaching the boiling temperature that it does to bring the tissue to boiling. The result is what amounts to a vapor seal protecting the deep tissue from the intense heat at the loop.

CONCLUSIONS

The previous considerations lead naturally to these conclusions.

(1) Consideration of sources of error and the results of measurements of generated temperatures indicate errors of from 300 to 800 per cent in the work of Caulk and Harris.

(2) There is little danger from overheating the tissue by use of the cutting currents for any distance greater than 3 Mm. Of course, damage is possible but reasonable care should avoid any trouble.

(3) Heavy coagulation currents when applied from small surfaces will generate dangerous temperatures to a depth of several millimeters. Care to use short applications of current or moving the electrode while applying the current will eliminate the danger.

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BRIEF COMMUNICATIONS
AND CASE REPORTS

ACUTE MECHANICAL INTESTINAL OBSTRUCTION CAUSED BY ACUTE APPENDICITIS *

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Case Report.—The patient, age 27, complained of persistent generalized abdominal pain which had started 12 hours previously. The pain, which had shown a tendency to localize in the right lower abdomen, was constant though somewhat colicky. Vomiting occurred once. During the preceding five years the patient had had an occasional similar attack, lasting from one to two hours, which subsided spontaneously.

The physical examination was essentially negative except for marked tenderness in the right and left lower abdomen and by rectum, more intense on the right side, which also showed a moderate degree of rigidity. Temperature 100.2° F. White blood cells 18,000, 94 per cent polymorphonuclears. There was 3+ acetone in the urine. A diagnosis of acute appendicitis was made.

Operation.—Under general anesthesia, the abdomen was opened through a right lower rectus incision. The appendix was acutely inflamed, covered with fibrin, and was about 10 cm. in length. As it was being delivered into the wound, its distal portion was discovered to completely encircle a loop of terminal ileum, which was black in color and markedly edematous. The appendix was bound down at its tip so as to completely obstruct the loop of bowel. There was a considerable amount of free fluid in the pelvis. The tip was freed from its adhesions, which released the constriction of the loop of bowel. The appendix was then removed and the stump inverted. The released loop of bowel meanwhile was kept covered with hot lap pads until sufficient color returned to justify an assumption that gangrene would not occur, after which the cecum and terminal ileum were returned to the peritoneal cavity and the wound was closed without drainage.

Convalescence was smooth except for a slight rise of temperature and some vomiting. A moderate degree of ileus resisted treatment rather stubbornly but was finally controlled satisfactorily. The wound healed by primary union.

Pathologic examination revealed an unusually long appendix (10 cm.). Microscopically, it showed a typical acute inflammation that had begun in the mucous membrane and had caused a destruction of the inner coats. There were marked edema of the submucosa, and throughout all coats a widespread infiltration with lymphocytes. Diagnosis.—Acute appendicitis.

The case is shown as a surgical curiosity, as I have been unable to find any report of a similar occurrence. One might speculate as to what caused the appendix to occupy its position encircling a loop of small bowel. From the patient's history it would be justifiable to assume that a similar mechanical obstruction had taken place on previous occasions, but had spontaneously relieved itself.

DISCUSSION.—DR. WM. F. MACFEE (New York) said that although obstruction following operation for acute appendicitis is a fairly common event, obstruction associated with the appendix and occurring before operation is relatively infrequent. Ways have been described, however, in which such obstruction can occur, perhaps the most common being the result of adhesions following some inflammatory process around the appendix. Obstructive bands are not infrequently found in the right lower quadrant in patients not previously operated upon. Another reason for preoperative obstruction would be pressure or angulation of a loop of intestines due to an abscess or tumor in the region of the appendix, and a third cause would be intussusception associated with inflammatory or other changes in the appendix. Still a fourth way in which the appendix can cause obstruction, as was illustrated in Doctor Lewis' case, is that, during some previous attack of appendicitis, the tip of the appendix became adherent to the parietal peritoneum, the mesentery, or, as in the present instance, to the small intestine, with the appendix then acting exactly as an adhesive band, a sling being formed into which a loop of intestine might be forced or engaged. Once this transpires, the ensuing swelling gradually cuts off the circulation of the loop of intestine, and it is also possible that the circulation of the appendix is likewise obstructed by the swollen intestinal loop. In Doctor Lewis' case, the question would arise as to whether the obstruction or the appendicitis was primary. The changes in the appendix may have been due to interference with its circulation brought about by the obstructed, swollen loop of intestine.

DR. SEWARD ERDMAN (New York) cited the fact that numerous cases have been reported in which a Meckel's diverticulum has acted as an obstructive band strangulating the intestine. Similarly, adhesions at the tip of an otherwise free appendix would tend to form a band under which the gut could easily slip.

DR. KENNETH M. LEWIS agreed with Doctor MacFee's explanation of the way in which the obstruction probably occurred, but felt that an acute attack of appendicitis preceded the adherence of the appendix to a loop of bowel, after which the appendix acted just as would a band.

ACUTE INTESTINAL OBSTRUCTION FOLLOWING RADIUM TREATMENT OF CERVIX UTERI*

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Case Report.—A white woman, age 69, had had a supravaginal hysterectomy 35 years ago and later developed an epidermal carcinoma of the cervical stump, Grade 2. In June, 1935, she was given 1,625 mg. hr. of radium into the cervical canal and 2,925 mg. hr. against the surface of the cervix. In addition, she was given two courses of high voltage roentgen therapy: 2,400 R units in June, and 3,840 R units in September, four fields, three times around the pelvis. After this she had diarrhea for a short time.

In January, 1936, she was readmitted and was referred to me by Dr. T. C. Peightal. For one month, she had had occasional lower abdominal pain. Twenty-four hours before admission she was seized with lower abdominal pains of great severity, extending down

the front of both legs. Shortly afterward she began to vomit jejunal contents; this continued off and on at intervals.

Roentgenologic examination disclosed distention of the small intestine with fluid levels in the various dilated loops and a shifting fluid level in the stomach. There was no distention of the large bowel.

At operation, it was discovered that the ileum, about one foot from the ileocecal valve, was adherent to the serosa of the uterine stump. When brought into the wound, the ileum was found to have a marked cicatricial contracture with induration. The lumen was opened on its antimesenteric border and ulcerated mucous membrane could be seen in an area measuring 1x1.5 cm. It had a greenish yellow color. The lumen was completely obstructed.

Microscopic examination showed no evidence of malignancy, but well defined radiation necrosis with ulcer of the ileum.

Resection of the ileum was performed with lateral anastomosis. The patient did well for awhile and then began to show renewed signs of ileus. She developed a mesenteric thrombosis extending from the site of the anastomosis 200 cm. up the ileum. There were no twisting of the gut and no leakage. The dead bowel was excised and the viable ends brought into the wound. She died three days later.

It is our belief that this loop of intestine became adherent to the posterior surface of the uterine stump shortly after the supravaginal hysterectomy 35 years ago. Then the radium treatment to the cervical cancer caused a radium burn, with secondary ulceration, contracture and obstruction. She had had premonitory symptoms for some months until, finally, complete obstruction developed.

DISCUSSION.—This case is cited as revealing a comparatively new cause for intestinal stricture and obstruction. With the increasing use of radium, more such cases will arise. We have already had one other instance of chronic obstruction of the sigmoid due to radium treatment of the uterus.

Pemberton[1] called this complication to our attention in 1932, and other reports are beginning to appear. In this case, with carcinoma of the stump of the cervix, we were faced with a definite risk. It is agreed that surgery alone in this type of case is not as efficient as radium. It is also agreed that this type of case is apt to have peritoneal adhesions from the previous operation. Some have proposed an abdominal examination by celiotomy beforehand, but this seems radical, and moreover will not prevent the rapid reformation of adhesions. At present, it must be admitted that this complication, which may appear months after treatment, is one of the necessary hazards of the treatment. It is well to bear the possibility in mind, however, and operate, instead of being content with a diagnosis of obstruction with recurrence, and letting the patient die needlessly.

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DISCUSSION.—DR. JAMES A. CORSCADEN (New York) emphasized that Doctor White's report merits attention of the general surgeon as much as that of the gynecologist, because cases of this kind will continue to be seen, even more frequently than at present. The patient may be given up as hopeless because of a diagnosis of the condition as intestinal obstruction due to

carcinomatous extension, despite the fact that following the heavy dosage given they are likely to be free of carcinoma, and thus be denied the institution of remedial surgery.

About 4 per cent of the cases at the Sloane Hospital for Women, since 1933, have had some severe intestinal complication requiring surgical relief; and in reviewing the types of lesions, it appears that the difficulty seems to be the result of excessive roentgen therapy. The lesion is diffuse, involving all of the intestines, both small and large, below the umbilicus, and may consist of simple congestion, ulceration or perforation.

Experimental work has demonstrated conclusively that the intestinal mucosa is relatively very susceptible to radiation; in the specimens at the Sloane Hospital, the cloudiness and dissolution of the mucous elements and the normal appearance of the muscle have been very striking. In other cases, where radium is thought to be the more at fault, the lesion is more likely to be localized in the anterior wall of the sigmoid or in the wall of an adherent loop of small bowel. The more common—and probably the more difficult case to handle—is that in which both radium and roentgen therapy have been applied. There are two types: One exemplified by the patient described by Doctor White, in whom there seems to have been a loop of intestine either adherent before the time of the radium application or possibly held there during the time of its application; and the other in the rectosigmoid or sigmoid itself. In these cases, the uterus is often separated by three or four centimeters from the anterior wall of the sigmoid. A maximum dose of radium alone would not be sufficient to cause the necrosis and cicatricial contraction; it is the added effect of roentgen therapy that completes the damage.

The time of onset is anywhere from immediately after treatment to 22 months. Jones has reported cases seven years after the application of radium. The symptoms range from mild diarrhea to acute intestinal obstruction. The method of handling the condition is individual and varied. Only one generalization might be made: If the intestinal operation is undertaken within a year or so after the application of radium or roentgen therapy, it is wise to interfere with the injured portion of the intestine as little as possible. In the few cases where attempts have been made to remove it, there has been failure of healing of the intestine with ulceration and fecal fistula. Where there has been a colostomy and later side-to-side anastomosis, some of the patients have done well. From the practical standpoint, one is dealing with tissue almost devoid of circulation due to the injury to the intima from the rays.

DR. BEVERLY C. SMITH (New York) concurred in the prediction that the general surgeon would probably see an increasing number of cases with intra-abdominal pathology of the intensive radiation of epithelioma of the cervix as the result of the large doses of roentgen therapy and radium, now being given. In this connection he reported the following case:

Case Report.—Unit No. 323288, a woman, age 56, was admitted to the Sloane Hospital on December 18, 1931. Following a biopsy which showed squamous cell epithelioma of the cervix, she was given the following radiation: 150 mg. in the uterine cavity, filtered by 0.5 mg. of lead, for 36 hours, and 25 mg. in each vaginal fornix, in steel needles with 2 mg. of lead filter and separated from the mucous membrane by 0.5 cm. of gauze, for the same period, totaling 5,400 mg. hours of treatment. The epithelioma on the posterior lip of the cervix extended to the external os, did not involve the

cervical canal and showed ulceration 2.5 cm. in diameter, extending to the posterior vaginal reflection. The broad ligaments were apparently not involved. From February 24, 1932, to September 12 (seven months) she received a total of 3,000 R roentgen ray treatments divided over (1) anterior lower abdominal, and (2) posterior gluteal fields, each 20x20 cm. She received, in all, 50 roentgen ray treatments, divided into three series. The epithelioma disappeared under treatment and her general health was good. On September 19, 1933, 22 months after radiation and 11 months after the roentgen ray treatments had ceased, she was admitted to the Presbyterian Hospital, with symptoms of intestinal obstruction which were partially relieved by treatment, but recurred, and on October 2, 1933, she was explored for an intestinal obstruction. A gangrenous area of terminal ileum 2x2 cm., 12 cm. proximal to the ileocecal valve, was found adherent to the cecum, and an area of lower sigmoid presented for 12 to 15 cm. a white, flaccid appearance typical of complete gangrene. The edges were sharply delimited. This had perforated, and there was a lower pelvic peritonitis. The gangrenous sigmoid and ileum were brought up into the wound and excised, leaving the patient with two fistulae. Her condition was such that an extensive resection was not thought advisable. Following the operation, she sloughed out more sigmoid and ileum so that the two fistulae openings emptied into a localized abscess in the left iliac fossa, which was lined with fine pale granulations showing little evidence of repair. She died on December 13, 1933, of inanition and sepsis in spite of all supportive treatment. The autopsy revealed no further extension of gangrene of the gut other than that seen at operation, a drained iliac fossa, peritoneal abscess, fibrosis of the submucosa of the bladder vessels with partial obliteration of their lumen, fibrosis of all tissues of the pelvic wall, and thrombosis of the left hypogastric vein. There was no evidence microscopically of residual epithelioma in the cervix, vaginal wall, or the regional lymph nodes. The striking features of this case were the onset of gangrene of the gut 22 months after radium treatment and 11 months after roentgen ray treatment, and the complete necrosis of portions of the sigmoid and ileum with perforation, peritonitis and fistulae formation which resulted in death.

INTESTINAL OBSTRUCTION CAUSED BY A DRIED PEACH

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Intestinal obstruction due to food is not common. In a series of 5,363 autopsies from October 15, 1914, to November 19, 1935, at the University of Kansas Hospitals, no other case of intestinal obstruction due to food is recorded. The following case is an unusual instance of such an occurrence.

Case Report.—E. P., a colored female, age 76, became suddenly ill February 17, 1935, with severe abdominal pain. This was followed by nausea and vomiting. A diagnosis of intestinal obstruction was made. The patient died in her home the following day after an illness of 24 hours. A coroner's inquest was held.

Autopsy Report.—The body was that of a colored female, age about 76, and weighing approximately 250 pounds. The jaws were edentulous with marked absorption of

the alveolar ridges. The abdomen was obese and slightly distended. With the exception of a small umbilical hernia and some edema of the lower extremities, the remainder of the external examination was negative.

Inspection of the abdominal cavity showed the umbilical hernia to be filled with omental fat. The stomach and small intestines were distended with gas and fluid. This was most marked in the terminal ileum while the colon was reduced in size and empty. The serosa of the ileum was injected, and in a few places granular, but no other signs of an acute peritonitis were present. There was only a slight increase in free peritoneal fluid. There was no volvulus, intussusception, adhesive bands or "kinks" to account for the obstructed appearance of the gut.

The cause of the obstruction could be palpated in the ileum at the ileocecal valve.

FIG. 1.—Drawing showing swollen dried peach lodged in the terminal ileum at the ileocecal valve.

On opening the terminal ileum and cutting toward the valve, a light yellow ovoid body was found in the lumen of the gut (Fig. 1). This was lodged within the ileocecal opening and the folds of mucosa extending into the cecum were swollen and edematous. The circumference of the valve appeared to be normal and no scarring or evidence of ulceration could be noted.

When removed and examined the foreign body had the appearance of a dried peach which has been soaked in water prior to cooking. The ragged inner surface next to the seed and a small blemish on the skin side could readily be recognized.

The other findings at autopsy were of a chronic nature, namely, a chronic myocarditis, cholecystitis and cholelithiasis with a stone in the cystic duct, and arteriosclerotic nephritis.

Further history relative to the deceased's diet was obtained. The family stated that two days prior to her death, or about 24 hours before the onset

of her symptoms, she had eaten a raw dried peach while her daughter was washing and preparing some for cooking.

From the history and findings at autopsy it is apparent that the patient's death was due to intestinal obstruction caused by an indigested dried peach. Having no teeth the patient evidently swallowed the peach with little or no mastication.

VAGINAL ANUS *

TWELVE YEAR POSTOPERATIVE FOLLOW UP

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Case Report.—The patient, a female, at the age of eight, was admitted to Roosevelt Hospital, April 16, 1924, complaining of fecal incontinence with occasional nausea and vomiting. She had been incontinent since infancy. Her past history was otherwise irrelevant.

Physical examination revealed that there was no anal opening at the normal site; in its place, there was a deep depression of the perineal skin and underlying soft parts. The vulval cleft, clitoris, labia majora, urethral and vaginal openings were normal. There was, however, an opening of the rectum, separated from that of the vagina by a corrugated septum, apparently formed by the joined posterior ends of the labia majora. The hymen was intact. This misplaced opening of the rectum admitted the tip of the little finger. It was more of a transverse slit than a rounded, puckered, anal opening.

Operation.—The incision was begun in the introitus of the vagina, carried well around and downward to either side of the misplaced anus and extending further down in the midline of the perineum to the region of the tip of the coccyx. The anus was dissected, with great care, from its position in the vagina, precaution being taken to preserve the blood supply of the lower rectum, which had to be mobilized. The borders of the levator ani muscles were definitely identified and the anus and terminal three inches of the rectum were brought downward and backward and the anus sutured with interrupted fine silk to the skin. There seemed to be, in the region toward the coccyx, a rounded muscle superficial to the levator ani muscles which gave one the impression of a poorly developed sphincter ani. This rudimentary sphincter was sutured around the terminal one-half inch of the rectum with interrupted sutures of fine chromic catgut. The levators were also sutured together around the lower portion of the terminal rectum in order to be sure that the rectum would obtain a sphincteric action from the levators in case the rudimentary sphincter ani muscle did not function properly. The perineum was carefully built up over the newly placed rectum and the vagina sutured. A small rubber tissue drain was placed in the lower portion of the perineum just anterior to the rectum. There was practically no tension exerted on the mobilized rectum as it was brought down and sutured in its new position. In fact, there seemed to be a redundancy of the rectum, so that we did not anticipate that it would retract and pull upward as healing took place.

Postoperative Course.—An uneventful recovery ensued. Fecal incontinence persisted up to the twenty-fifth day, at which time the patient was allowed out of bed. From then on, she was able to use the commode or go to the toilet. She had perfect control over defecation four months after operation.

In the summer of 1935 she became pregnant, and was advised not to let the pregnancy go to full term, unless it should be delivered by cesarean section. She was aborted before the third month of pregnancy.

COMMENT.—Vaginal anus is one of the most common of the congenital defects of the anus and rectum, occurring in about 40 per cent of the group of defects where the rectum may open into the urethra, bladder, uterus or vagina.

Collins, at the Rotunda Hospital in Edinburgh, found only one case of vaginal anus in 16,000 obstetric cases. Winckel found only a single case of this condition in 12,000 babies at the Dresden Hospital. Morgagni records the case of a woman with an abnormal opening of the rectum into the vagina who lived to be 100 years of age, and who never knew of her congenital defect. Paschal reported that a woman with a vaginal anus gave birth to three children. She did not know of her defect, nor did her husband, nor did the accoucheur who delivered her on the three occasions.

The symptoms are variable, depending upon the size of the anal opening in the vagina. If there is no sphincteric muscle surrounding the misplaced anus, incontinence is the chief symptom. If the opening is small and slit-like obstructive symptoms are soon manifest.

The ideal time for operative intervention is from the eighth to the twelfth year, when the parts have become fairly well developed, and before menstruation takes place. The basic principles of the operation are: first, an easy and painless outlet for the feces; second, good sphincteric control; and, third, a position of the outlet well back in the midline of the perineum. A good result is usually assured within six months to one year, especially if the sphincteric muscle is found already around the terminal rectum, or when it is found in the region of the tip of the coccyx. If no definite sphincteric fibers are identified and the levator fibers are utilized, one year to one year and one-half may elapse before any normally controlled movements occur. The operative mortality is low.

DISCUSSION.—DR. OTTO C. PICKHARDT (New York) recalled a similar case shown by him before the New York Surgical Society several years ago, in which he also had obtained good results. The condition was very rare, occurring about once in 10,000 births. When first seen, the natural impulse is to do something. However, conservatism should prevail, for early operation—whether palliative or extensive—is likely to prove fatal. The main reason for operating later is the lack of knowledge of the exact extent or size of the rectum, or of how far down it will come, until between the ages of eight and twelve, which as stated by Doctor Cave is the best time for the operation to be performed. The procedure to be undertaken will depend somewhat upon whether the anal opening is in the vagina. The farther back it is, the more extensive must the operation be. In Doctor Pickhardt's case, the opening was well posterior and so, in order to mobilize the rectum completely, it was necessary to remove the coccyx and a small portion of the sacrum. Following this, the rectum was freed from the vaginal wall, then pulled downward and out through the sphincter, which had been opened, and a generous cuff of mucosa was left. Postoperative care is most important.

HEADACHE AS A SYMPTOM OF CERVICAL RIB

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Much has been written on the subject of cervical rib and its associated neurologic and vascular symptomatology. Nowhere in the literature, however, is there mention of headache as a symptom of this anomaly. Two years ago one of us (M. A. L.) in association with Dr. Walter C. S. Koebig of Los Angeles studied a case (which will be published shortly) of cervical rib in which headache was the most prominent symptom. The case was that of a woman of 47, who for 12 years had had a left parietal and occipital headache. A most careful examination was made and all possible foci of infection were eliminated. The eyes in particular were examined and errors of refraction corrected. The headache persisted. Doctor Koebig then suggested that a left cervical rib, which was known to be present, might be the cause of the headache. As there was nothing else that had any evident causal relation with the headache, it was decided to remove the cervical rib. This was done and the headache promptly disappeared and has not returned since. Incidentally this patient has a daughter of nine who has bilateral cervical ribs but no headaches.

Case Report.—The patient, a girl, age 11, was admitted to the Hospital for Joint Diseases November 11, 1935. Her chief complaint was intense right-sided headache, mainly in the frontal and parietal regions. She had been suffering from this headache for two years. The pain was intermittent but severe. It came on rather regularly after rising in the morning and particularly after physical exertion, and was increasing in intensity, so that in recent months it interfered with her school work. On many occasions while in school the headache became so severe that she had to go home. Usually rest in bed for several hours afforded her relief. In addition, for the past five years, she has had attacks of pain in the right supraclavicular region which had recently become more frequent and more severe. During the month preceding her admission she had begun to experience pain and weakness in the right wrist.

The family history was irrelevant. Past history: measles, mumps and suppurative otitis media resulting in bilateral mastoiditis requiring mastoidectomy.

The physical examination showed a well developed girl with head tilted to the left. At the base of the neck on the right side there was a mass, hard in consistency, about two inches in the horizontal and one and one-half inches in the anteroposterior diameter. It apparently arose from one of the lower cervical vertebrae and extended laterally towards the clavicle. There was a marked pulsation in front of the mass and an easily audible bruit. In the left side of the neck there was no visible or palpable mass. The blood pressure in the right arm was 110/45, in the left arm 90/40. The radial pulses were equal in frequency and normal in rhythm. The eyes were normal except for a slight internal strabismus on the right side and a slight horizontal nystagmus. The rest of the physical examination was negative.

The anteroposterior roentgenogram of the neck (Fig. 1) showed a small cervical rib on the left side and a very large one on the right side. The right cervical rib was segmented, and extended from the body of the seventh cervical vertebra to the first rib; it appeared to be about two and one-half inches long.

The right cervical rib not only caused a conspicuous deformity of the neck, but seemed the most likely cause of the patient's suffering. Consequently, excision of the anomalous rib was advised and undertaken November 15, 1935. Considerable thought was given to the method of approach. As the rib seemed very superficial posteriorly, it appeared wise to use the posterior approach, hoping to completely avoid contacting the blood vessels. It was appreciated that the posterior incision would probably preclude adequate exposure and release of the lower attachment of the scaleni muscles, but on the other hand, it was anticipated that removal of the cervical rib alone would relieve
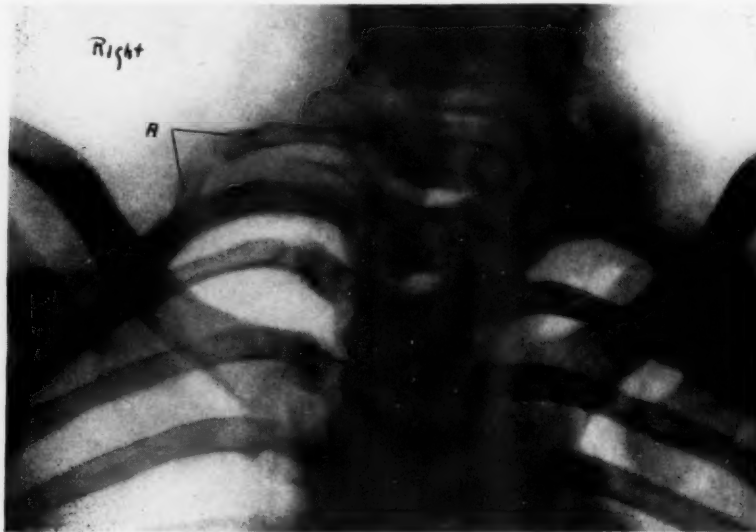

FIG. 1.—Anteroposterior view of cervicodorsal region. (A) Arrows point to a segmented cervical rib which extended from the body of the seventh cervical vertebra to the first rib. The apparent gap between the proximal and distal segments was found at operation to be cartilaginous, without any break in the continuity of the rib.

the symptoms. Accordingly a vertical incision was made along the anterior border of the trapezius muscle. At the base of the neck the incision was curved forward. By slow dissection the middle of the rib was exposed without cutting any major nerves and without encountering any anomalous blood vessels. The tissues in front of the rib were gradually elevated, exposing the whole of the rib which extended from the body of the seventh cervical vertebra to the first rib. The rib was cut through the middle, an apparently cartilaginous area. The proximal segment was removed first and then the distal portion was excised. As the soft tissues in front of and below the rib had been lifted en masse, there was little danger of puncturing the lung. The wound was closed without drainage and healed by primary union. The postoperative course was quite uneventful. The headache, pain in the neck and in the right wrist completely disappeared.

DISCUSSION.—Although strabismus and nystagmus may at times initiate or be responsible for headache, they manifestly had no such effect in the case cited, as the headache persisted after the strabismus was controlled by

corrective glasses, but disappeared promptly after removal of the anomalous rib.

The interesting question that naturally arises in a consideration of this case is, what is the pathogenesis of the headache? By the process of post hoc propter hoc reasoning the cervical rib caused the headache, but we are uncertain as to the exact mechanism. In the absence of any other explanation it may be assumed that the cervical rib, by its proximity, caused pressure upon the cervical sympathetic and the vagus nerves. This friction by reflex irritation caused the headache. This terminology is vague and unfortunately necessarily so because of our inadequate understanding of the function of the sympathetic system. Mayer[25b] in his paper on "The Neurologic Conception of Headache" stated: "The physical pain which we style headache arises from the sympathetic, trigeminal, occipital or upper cervical nerves, due either directly to disease of these nerves or to edema, increased pressure or circulatory changes which affect them. The brain itself has no nerves and feels no physical pain, so that an inevitable conclusion must be that pain itself is a purely mental state." In view of the fact that the dura mater within the cranium is supplied mostly by the second and third divisions of the trigeminal nerve and by *branches of the vagus*, irritation through direct pressure on any of their branches or stimuli referred through these nerves, which are distributed through the head and neck, may produce a pain within the cranium, that is, headache. Certainly a mass such as the anomalous rib removed from the case here recorded was big enough and occupied sufficient space in the neck to cause pressure upon, and irritation of, the vagus and the cervical sympathetics to give rise to reflex symptoms within the cranium.

. SUMMARY.—(1) A case is reported in whom the major symptom of a cervical rib was headache.

(2) The headache, which had been present for several years and had become not only very severe but disabling, has been completely and apparently permanently relieved by extirpation of a cervical rib.

(3) The patient had bilateral cervical ribs. The one on the left side was very small and, as is found in so many cases, gave no clinical manifestations other than a positive roentgenogram. The cervical rib on the right side was very large and was characterized locally by a mass and pain and by ipsolateral severe and increasing headache.

(4) The increasing headache may be explained on the basis that the cervical rib was growing and by its increasing size caused greater nerve irritation.

(5) The cervical rib occupying a large part of the area at the base of the neck inevitably pressed upon the vagus nerve, branches of which supply the cranial dura mater, thus establishing the potential physical basis of the headache.

(6) Mention is made of another case of cervical rib causing headache

observed by one of the authors. In this case, also, the headache was relieved by excision of the rib.

(7) From our experience it is logical to urge the removal of any cervical rib that is growing, as it is likely to cause symptoms resulting from irritation and pressure.

(8) The posterior approach to the cervical rib seems to us preferable to the anterior, especially when there is no evidence of pressure upon the subclavian vessels, since it is easier in this way to avoid injury to the major vascular and nervous structures in the neck.

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A SIMPLE METHOD OF MEASURING SKIN FOR SKIN FLAPS

JULIAN Y. MALONE, M.D.

MILWAUKEE, WIS.

I WISH to call attention to a simple method of measuring skin for skin flaps. The method has been found to be very satisfactory and eliminates the time consuming procedures usually employed to determine the availability of

FIG. 1.—Before the skin graft (anteroposterior view). Note the scar tissue at the bridge of the nose.   FIG. 2.—Before the skin graft (lateral view).

sufficient skin as well as the actual amounts necessary to fill in a given defect. Plaster or gelatin models, and caliper measurements are entirely eliminated.

The procedure consists of using damp chamois skin as the measuring medium. The chamois skin is cut to fit the defect and enough used to reach to the area from which the graft is to be taken. The chamois skin is then cut to represent the proposed flap. It is then swung into position onto the healthy skin and its outline traced on the skin with 10 per cent silver nitrate. When the patient is ready for operation therefor, the black outline of the silver nitrate indicates the line of incision and enables one to prepare the skin

without fear of destroying the markings. The graft may be made under local anesthesia if desired without the measurements being distorted. It is necessary to apply the silver nitrate long enough before the operation to allow it to turn black. The same procedure may be used in performing plastic operations where shifting, *etc.,* of the skin is involved.

It has been found that moist chamois skin may be manipulated the same as human skin and therefore, gives the operator accurate information not only as to the measurements but also how much tension will exist at the end of the operation. This information is very essential in order that the sutures will not be under tension and also to guard against constriction of the blood supply.

Figures 1, 2 and 3 illustrate the employment of this procedure. Due to the injury, the skin of the bridge of the nose was all scar tissue and the bone

FIG. 3.—Showing skin flap in place. FIG. 4.—After repair was completed.

was entirely missing. The area to be covered was marked off and the chamois cut to fit, allowance being made for the bone graft that would eventually be placed under the skin to build up the bridge. The bone graft form was determined by making a cast of the defect with molding wax. The chamois was then placed on the forehead and the position shifted until a flap could be turned down without constriction of the blood supply and without tension. The outline of the moist chamois was then marked off upon the forehead with silver nitrate. The following day the operation was performed, the skin flap fitting perfectly. Ten days later, the graft was cut from the flap and the flap returned to the forehead. By stretching it no skin defect of the forehead resulted. Several months later the bone graft was inserted completing the restoration of the nose (Fig. 4).
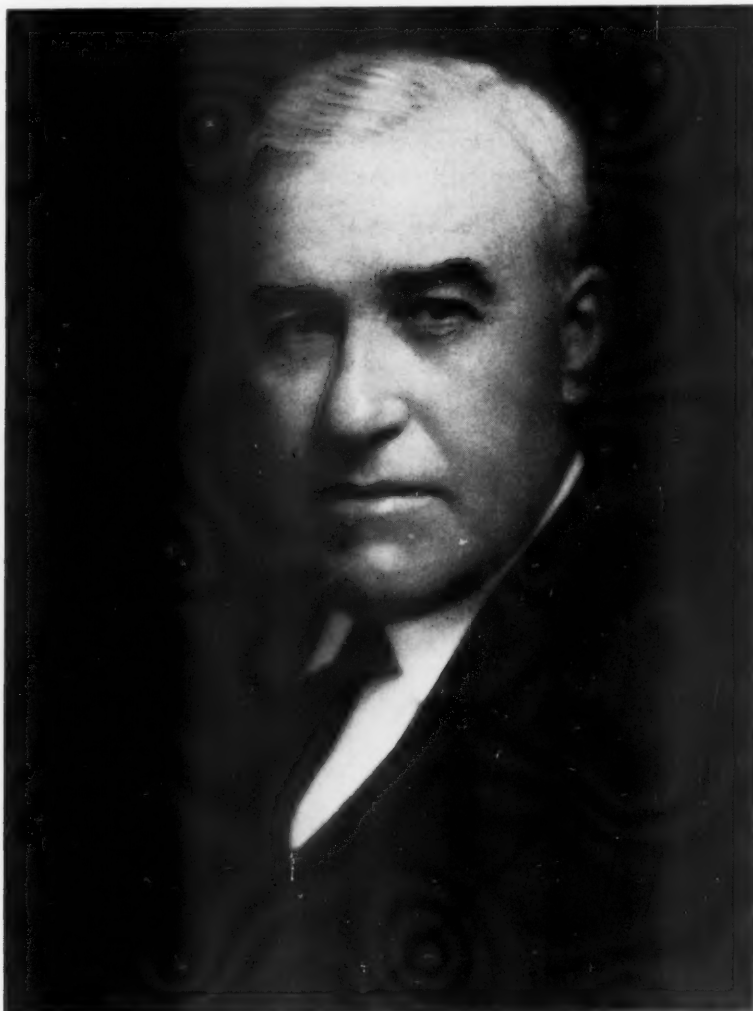
MEMOIRS

JOHN FOX CONNORS

1873–1935

JOHN FOX CONNORS was born in Tipperary, Ireland, on October 26, 1873, and died in New York January 5, 1935. He received the degree of

JOHN FOX CONNORS, M.D.

B.A. from St. John's College in Brooklyn in 1892, and the degree of M.D. from the University of New York in 1895. He served on the house staff of Charity (now Metropolitan) Hospital and from 1898 to the day of his death

was engaged in the practice of medicine in New York. In 1892, he received the Master's degree, and in 1929 the honorary degree of L.L.D. from his Alma Mater. In 1903 he was appointed visiting surgeon to Harlem Hospital and in 1922, when elected a fellow of the American Surgical Association, he became its surgical director. He was also consulting surgeon to the Stamford Hospital and to the hospital in Waterbury, Conn.

Both as resident, and later as visiting surgeon, Doctor Connors enjoyed a varied and active service, in which major traumatic surgery largely preponderated. This was especially the case in Harlem Hospital which receives a majority of its patients from the adjacent thickly populated Negro quarter, with whom the sudden flashing of the knife or razor, and the use of the pistol is proverbial. This experience was reflected in his contributions to surgery. To minimize the danger of uncontrollable hemorrhage in stab wounds of the chest he advocated prompt and wide exploration with the ligation of a possibly divided internal mammary or intercostal artery, and in the abdomen he reported a large number of lesions of the spleen and other important abdominal viscera. His contributions to the treatment of empyema were also noteworthy.

"Jack" Connors was intensely proud of his nationality. During the customary annual dinner some years ago of the American Surgical Association, the singing of the "Wearing of the Green" by one of the invited guests was preceded by a request for any Irishman to make his presence known. Immediately "Jack" Connors stood up, and as quickly resumed his seat amidst the applause of his colleagues. He possessed the virtues of those who hail from the "Emerald Isle" with none of their vices. He was a politician, not so much to advance his own interests as those of his friends. Once a friend, always a friend; most cordial and anxious to be of service to his fellow man, and never animated by a spirit of revenge or enmity.

His surgical skill was of a high order, both in actual therapy as well as in surgical technic and judgment. His loss is keenly felt by many friends, who will always affectionately remember him. What greater tribute could one wish to leave as a heritage?

ELLSWORTH ELIOT, JR.

FRANCIS STUART MATHEWS

1869–1936

IN THE death of Francis Stuart Mathews on February 17, 1936, the surgical profession of New York City lost one of its outstanding members,

FRANCIS STUART MATHEWS, M.D.

a man combining ripe experience and rare skill with a lovable, inspiring character.

He was born in Washington, Pa., on November 14, 1869. His father, William Johnston Mathews, a storekeeper, came from a family of Scotch-Irish Presbyterians who had been settled in Pennsylvania for several generations. His mother, Frances Sage Pelletreau Mathews, was of Huguenot stock, whose ancestors had emigrated to Southampton, Long Island, following the massacre of St. Bartholomew. A forbear in whom Doctor Mathews took particular interest was his great-grandfather, Elias Pelletreau, a colonial silversmith of Southampton, examples of whose work are on exhibition in the Metropolitan Museum of Art in New York City.

When Doctor Mathews was five years old his father died and his mother with her four children went to live with an uncle in the little pioneer community of Prairie du Sac, Wisconsin. There he attended the district school in winter and worked on his uncle's farm in summer. During this period he developed an interest in birds which remained a lifelong source of study and pleasure.

At the age of 14 he was sent back to Pennsylvania to attend preparatory school and college. After taking his bachelor's degree from Washington and Jefferson in 1890, he entered the College of Physicians and Surgeons, New York City, and was graduated in medicine in 1893. The next three years he spent at Roosevelt Hospital, the first two on the surgical service of Dr. Charles McBurney and the third as resident on the gynecologic service.

With the background of a devout home, a youth in which there was a full share of plain living and hard work, and an excellent medical education, he was ready to start practice.

For 12 years he worked in the gynecologic clinic at Roosevelt Hospital. He also assisted the late Dr. Edwin B. Cragin in private practice. When Doctor Cragin ultimately offered to make him an associate at the Sloane Hospital for Women, it was a difficult decision for Doctor Mathews, as its acceptance meant limiting himself to this specialty. He chose to remain in general surgery, but the experience gained in gynecology stood him in excellent stead throughout his subsequent career.

At the outset of his practice he was appointed assistant surgeon at St. Mary's Free Hospital for Children. Within a short time he became pathologist as well, a post he held for eight years. The training gained in this position as well as at the Woman's Hospital, where he worked in pathology for two years, gave him a grounding which few surgeons acquire.

He continued on the staff at St. Mary's, becoming attending surgeon, a position he held until the hospital closed its doors. After he had been in practice five or six years he was made an assistant surgeon at General Memorial Hospital and some years later at St. Francis Hospital in the Bronx.

These latter two positions he relinquished when, in 1913, he was appointed to the surgical staff at St. Luke's Hospital. This was a fortunate move both for St. Luke's and himself. His growing reputation added to the prestige

of the hospital while he in turn found a congenial field and fuller scope for the development of his career. His private practice, already well established, increased steadily with a large following among both profession and laity.

The intense activity of these fruitful years was interrupted by beginning attacks of angina pectoris eight years before his death, when he was 58 years old. From this time on he gave up routine ward duty, but in spite of several periods of absence from work on account of ill health he retained a large practice and was in increasing demand as a consultant.

Doctor Mathews maintained a connection with his alma mater, the College of Physicians and Surgeons, first as instructor in gynecology, and later as clinical professor of surgery.

His achievements were recognized by membership in the New York Surgical Society, which he served as president, the American College of Surgeons, the Interurban Surgical Society and the American Surgical Association.

As a surgeon, Doctor Mathews had an eminently rational and scientific point of view and was never led away by fads of the moment. His judgment was sound and his conclusions, based on broad knowledge and large experience, often seemed intuitive to his assistants. He was never one to operate first and diagnose afterward, but on the other hand made up his mind promptly and boldly, where boldness was called for. He was a deft, practically ambidextrous operator, never seeming to hurry but finishing in a minimum of time. His incisions were moderate in size, the work to be done was accomplished as simply as possible without fussiness or hesitation and, as a result of gentle and expeditious handling, the patient usually made a notably uneventful convalescence.

Doctor Mathews was a frequent, although not voluminous contributor to surgical literature. His papers, covering a variety of subjects, are full of sound observations and comment and well repay rereading. Among the earlier ones is that describing his method of finger enucleation of the tonsil, developed at St. Mary's Hospital for Children at a time when tonsillectomies were frequently incompletely done. Among his later papers are two studies from his experience in the surgery of breast cancer which, thanks to the painstaking and almost complete follow up which he was able to make, as well as the uniform method of treatment carried out throughout the extensive series, are most satisfactory and authoritative contributions to the subject.

His interest in historic medicine was evidenced by a delightful paper on John of Arderne, and in the month before his death he gave no less than three talks on cultural medicine before different groups.

People trusted Doctor Mathews because of his integrity. They knew that his judgments were based on the merits of a case without consideration of self interest. They loved him because of his humanity, kindliness and devotion to their interests. The physicians who depended on his help in

their surgical problems, and the patients who benefited from his ministrations, were alike enthusiastic in his praise.

His professional success depended not one iota on pushing aggressiveness. On the contrary, he was modest and retiring and the hospital appointments and honors which came to him were offered in recognition of his abilities and not sought out. He completely lacked the egotism and acquisitiveness which characterize many successful men, but strove rather to share opportunities and push the interests of those associated with him.

This thoughtfulness for others and desire to help them was one of his outstanding characteristics. He was always ready to assist a younger colleague in a case, if by this support the patient could be satisfied, rather than have him fall into his own hands. On his hospital service he saw to it that his assistants had as many and as interesting cases as it was possible to pass on to them.

One of Doctor Mathews' most delightful qualities was his keen sense of humor with which his conversation sparkled. He was a man of broad culture and could quote the Bible and Shakespeare in an inimitable way.

Although he was devoted to his profession and found his chief joy in it to the day of his death, he had other interests. Reference has already been made to his knowledge of birds. This was enhanced by trips to the West Indies where the bird life attracted him as well as the history of the Islands. He took a keen interest in the American Museum of Natural History where he was named research associate in experimental biology. He was a deacon in the Presbyterian Church.

In 1923, his alma mater, Washington and Jefferson, conferred on him the degree of Doctor of Laws.

His wife, the former Miss Julia E. King, of Columbus, Ohio, survives him as do their three children. He was fortunate in having his older son, Dr. Frank P. Mathews, associated with him in practice during his last years.

On February 17, 1936, after his usual hospital visit in the morning, he was examining a patient in the office when stricken with an attack of coronary thrombosis. He was relieved of pain by sedatives and was apparently resting comfortably that evening, when, in the midst of a conversation with his physician he suddenly died. It was an ending which one might envy, yet with his splendid faculties unimpaired, how much there is to regret that he could not have been spared a longer time.

MORRIS K. SMITH.

MALCOLM LaSALLE HARRIS

1862–1936

MALCOLM LaSALLE HARRIS died in the Milwaukee Sanitarium at Wauwautosa, Wisconsin, on March 22, 1936, following a long illness resulting from a cerebral hemorrhage and secondary complications. Doctor Harris was

MALCOLM LaSALLE HARRIS, M.D.

born June 27, 1862, in Rock Island, Illinois, the son of Samuel G. and Frances Green Harris. He attended the public schools in Iowa and in 1882, when he was 20 years old, was graduated from Rush Medical College. After

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serving his internship in the Cook County Hospital, he began practice in Chicago in 1884, where he continued to reside up to the time of his death, teaching in the County Hospital and also serving as Professor of Surgery in the Chicago Polyclinic.

Following reorganization of the American Medical Association in 1901, Doctor Harris became a member of the House of Delegates and served the American Medical Association continuously in various capacities up to the time of his incapacity due to illness. He had been successively a member of the House of Delegates, a member of the Board of Trustees, and Chairman of the Judicial Council. He was elected President of the American Medical Association in 1928, serving during 1929 and 1930. He had previously, 1898–1899, been secretary of the Section on Surgery and Anatomy, at a time when Dr. William J. Mayo was chairman of the Section. He was a member of the Board of Trustees of the American Medical Association from 1903 to 1918, and a member of the Judicial Council from 1918 to 1928.

As a surgeon, Doctor Harris had been honored with membership in the International Surgical Association, the American Surgical Association, the Western Surgical Association, and the American Association for Clinical Surgery. He served as President of the Chicago Medical Society, the Chicago Surgical Society, the Chicago Pathological Society, and the Western Surgical Association. At the Henrotin Hospital he served as Secretary of the Board continuously from 1889 to 1935 and was instrumental in the financing and construction of the new Henrotin Hospital. His contributions to medical literature include not only the translation and editing of Braun's "Local Anesthesia," and contributions to the Oxford, Keen's and Bryant's "Systems of Surgery," but also many periodical contributions not only in surgery but also in the field of medical education and more recently of medical economics.

His knowledge of the literature of surgery was catholic and his discussion of surgical questions was precise and illuminating and devoid of loose thinking and generalization. During his many years of service at the Cook County Hospital his work was eagerly attended by the younger members of the staff who recognized in him a surgeon of unusual skill and seasoned judgment. Doctor Harris was elected to membership in the American Surgical Association in 1900 and continued in active membership until the year preceding his illness. He will be greatly missed by his colleagues and many friends, for he was a man of wide acquaintanceship and recognized everywhere as a capable leader in medical, civic and financial affairs.

VERNON C. DAVID.

LEONARD FREEMAN
1860–1935

ON DECEMBER 16, 1860, there was born to Dr. Zoeth Freeman and Ellen Ricker Freeman at Pine Grove, near Cincinnati, Ohio, a son Leonard. Dr.

LEONARD FREEMAN, M.D.

Zoeth Freeman practiced medicine in Cincinnati for years, and later became the personal physician to President U. S. Grant. During the years of his

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Presidency they, with their son Leonard, lived in Washington. These years of residency in Washington during the stirring post-war period were a stimulating influence to the youthful Leonard.

Leonard Freeman received his primary education from tutors and in private schools. In 1882, he was graduated from the University of Cincinnati with the degree of B.S. In his youth he became interested in archeology, an interest he retained throughout his life. He studied ornithology with Charles Drury, a prominent naturalist of Cincinnati, whom he accompanied on several field trips, the most extended being a summer spent in the Everglades, Florida. His early studies made him a keen observer, a faculty he further developed and which later became valuable in the practice of his profession. An example of the correlation of his ornithologic and surgical observations is found in his comparison of the normal stomach of a granivorous bird with the stomach in congenital pyloric stenosis, an original, plausible explanation of the baffling etiology of this condition. (Colorado Medicine, vol. 20, p. 78, March, 1913.)

Fond of the out of doors, a lover of nature imbued with the spirit of adventure, he was prompted to take many trips into the wilds of Michigan and Canada. Over fifty years ago with two classmates, Otis Cameron and Fred Sampson, he made a canoe trip from Cincinnati up the Miami and Erie Canal to Lake Erie, thence through the Great Lakes to Duluth, Minnesota, truly an undertaking worthy of a "Voyageur."

He studied medicine at the Medical College of Ohio where he took his medical degree in 1885. He served as intern in the Cincinnati Hospital. The next three years were spent abroad at the University of Göttingen. He studied pathology under Virchow, bacteriology with Koch, and then pursued postgraduate clinical work in Vienna and Berlin.

Returning to Cincinnati he taught pathology and bacteriology in the Ohio Medical College and served as pathologist and bacteriologist to the Cincinnati Hospital from 1889 to 1891. During these years he was associated with Dr. Phineas S. Connor, then one of the ranking surgeons of the United States.

In 1891, his health broke and he went to Colorado. On regaining his strength he took a sea voyage on a sailing vessel to Honolulu. While in the Hawaiian Islands he spent some time in the Leper Colony at Molokai. On his return to Cincinnati, in 1894, he married Miss Amanda Frank. In 1895, he went to Denver, Colorado, to live. They had three sons: Frank, the eldest, an engineer living in Denver; Paul, who died in 1917; and Leonard, Junior, a surgeon who was associated with his father. His wife died in 1904. In 1906, he married Miss Jean Wright of Denver.

In 1897, Doctor Freeman became a member of the faculty of the Denver and Gross Medical College and continued to serve on the faculty when that school merged with the University of Colorado. For years he was professor of surgery and Head of the Department of Surgery of the University of Colorado Schools of Medicine.

On December 27, 1935, Dr. Leonard Freeman died of coronary thrombosis at his home in Denver, Colorado. A long, active, and productive professional career was closed at the age of seventy-five, after an illness of but

a few days. From the day of his graduation from the Medical College up to the day of the onset of his brief but fatal illness he assiduously studied, and impressively taught, practical surgery.

Dr. Freeman was a man of vigorous and powerful physique, possessed of the spirit and determination of the true pioneer. Cast in a big mold, bigness was expressed in his every thought and deed. Unostentatious, guileless, devoid of pettiness and self-aggrandizement, he could not comprehend the absence of these qualities in others, therefore he was frequently imposed upon by those less sincere and less frank.

A man of strong convictions, he not only conceded but defended the right of others to enjoy the same privilege. His brusque manner was but a superficial affectation; a defense reaction to mask a sensitive nature and a big tender heart. Only those who really knew Doctor Freeman could realize how easily he was moved and how deeply he could feel. He had schooled himself in the control of his soul-stirring emotions. He was the personification of honesty, the soul of honor and justice, aggressive and courageous, a staunch defender of the weak and a champion of the righteous.

Doctor Freeman was an ardent student of primitive as well as contemporaneous surgery, both foreign and American. Blessed with an analytical, receptive mind and an unfailing memory, with his splendid training in pathology and bacteriology, it was but natural that he became and was for many years one of America's outstanding resourceful surgeons.

He was a keen observer, a clear and logical thinker and a forceful, terse speaker. What he said or whatever he did was based upon knowledge and personal experience. In his studies, writing, teaching, consultation, operations and discussions he demonstrated a rare faculty of grasping essentials. He faced facts. He was authority.

Doctor Freeman was a world traveler. On numerous journeys through Europe, Central and South America, on voyages to Japan, China, the Philippine and South Sea Islands he never failed to study the hospitals and surgeons of these often remote countries. He availed himself of every opportunity to delve into primitive and aboriginal surgery. These studies resulted in several important papers on "Primitive and Aboriginal Surgery." His contributions to surgical literature were numerous, of wide range and valuable.

He was ex-president, a consistent attendant, and a stimulating scientific contributor of the Denver Clinical and Pathological Society, the Medical Society of the City and County of Denver, the Colorado State Medical Society and the Western Surgical Association. He was an enthusiastic member of the American Surgical Association. He was also a member of the International Surgical Association and the American College of Surgeons.

The high regard with which Doctor Freeman is held throughout the West is evidence of his excellent surgery and his stimulating influence on the vast number of his former students and the younger members of the profession.
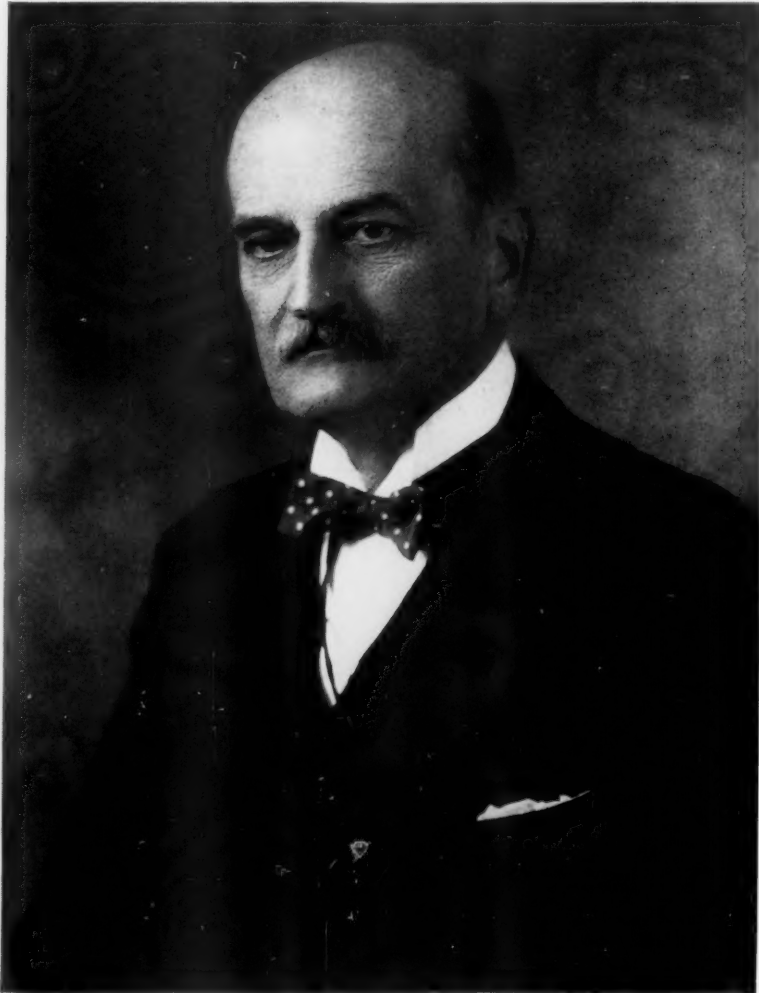
Doctor Freeman is dead, but the memory of so great a surgeon, so inspiring a teacher, so true a man, and such a loyal friend can not die.

CASPER F. HEGNER.

WILLIAM JOHNSON TAYLOR
1861–1936

WILLIAM JOHNSON TAYLOR, a Fellow of The American Surgical Association since April, 1887, died at his home in Philadelphia January 22, 1936.

WILLIAM JOHNSON TAYLOR, M.D.

He was born in Worcester County, Md., October 13, 1861. He was graduated from the Medical School of the University of Pennsylvania in 1882

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and then served a two year internship at the Pennsylvania Hospital. A few years later he became Assistant to W. W. Keen in his private work and at the Orthopedic Hospital and Infirmary for Nervous Diseases. It was at this hospital that S. Weir Mitchell and W. W. Keen developed a large neuro-surgical clinic and Taylor was Keen's right-hand man from that time until the latter's retirement. He thus assisted Keen in all his early brain operations. Later he succeeded Keen as surgeon to the hospital. Doctor Taylor served the Orthopedic Hospital continuously and conscientiously for 50 years, a service which was gratefully acknowledged in 1935 by both the Board of Managers and the Staff of the hospital. In addition to his service at the Orthopedic Hospital he was for many years surgeon to St. Mary's and St. Agnes' Hospitals.

Doctor Taylor was what might well be styled a sane surgeon. He was well trained in the art and was a capable and conscientious operator. He was held in very high regard not only by his friends and colleagues but also by the general profession, largely because of his fine character and his well known stand on matters relating to professional and educational standards.

His greatest professional interest was the College of Physicians. He served this institution for a long period of years on various committees and conspicu-ously on the Building and Finance Committees. He was made President of the College in 1909 and occupied the chair for three years. He was very active in the Philadelphia Academy of Surgery, being Secretary for many years and President in 1908–1909.

An interest outside of medicine to which he gave a great deal of his time was the Philadelphia Library, an old and honorable institution founded by Benjamin Franklin. Doctor Taylor was President of the Board for two years.

When the United States entered the World War, Doctor Taylor was 56 years of age. He accepted the rank of First Lieutenant and went to France with the Pennsylvania Hospital Unit, Base Hospital No. 10, which on arrival in France was assigned to the British service and given General Hospital No. 16 at La Tréport. He was with this Base Hospital throughout his service and was advanced to Captain September 10, 1917, and to Major January 9, 1918. On November 11, 1918, he was made Lieutenant Colonel. His war service was characterized by the same earnest enthusiasm that was conspicu-ous in his professional life both before and after the War.

Sympathy, kindliness and consideration of others were outstanding charac-teristics of William Johnson Taylor. In 1891, Doctor Taylor married Miss Emily Buckley Newbold and she with their four children survive him.

JOHN H. GIBBON.

JAMES TATE MASON
1882–1936

By the death of James Tate Mason on June 20, 1936, the surgical profession lost one of its most energetic and lovable characters. Doctor Mason was born at Lahore, Orange County, Virginia, on May 20, 1882. His grand-

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JAMES TATE MASON, M.D.

father, Captain Claiborne Rice Mason was one of Stonewall Jackson's engineers during the Civil War and later was instrumental in building the Virginia Midland Railroad; in addition, he constructed the greater part of the Chesapeake and Ohio line. Doctor Mason's father, Dr. Claiborne Rice Mason, also served under Stonewall Jackson until wounded and taken to Elmira where he was kept a prisoner of war until the surrender at Appomattox. Doctor

Mason's mother, Mary Moore Woolfolk, was a native of Orange County, Virginia.

Doctor Mason attended the Locustdale Military Academy until 1901, when he entered the University of Virginia Medical School, graduating in 1905. During his school and college years, he forecast his later popularity by being greatly in demand among his mates; active in athletics, a natural leader, he was a favorite with both schoolfellows and instructors. During the summer vacations he served as an assistant to Colonel James A. Frazier, owner and manager of the Rockbridge Alum Springs, thus cheerfully helping to make his way through school. Following his graduation in 1905, he passed the examination of the Virginia State Medical Board in Richmond and began a Junior Internship in the Philadelphia Polyclinic, now known as the Post-Graduate School of the University of Pennsylvania. A residency at the Municipal Hospital of Philadelphia followed.

In the spring of 1907, as ship's surgeon, Doctor Mason came around the Horn and arrived in Seattle in the summer of the same year. Shortly thereafter, he became surgeon for the Pacific Coast Coal Company with mines at Franklin and Black Diamond, and in Franklin he did general practice for two years, making—as he did throughout his life—many staunch friends. In 1909 he moved to Seattle and shortly thereafter became physician to the county jail and, two years later, Coroner of King County. In 1914 he was appointed superintendent and Chief Surgeon of the King County Hospital which position he held until 1920.

On January 3, 1912, he married Laura DeWolfe Whittlesey of Seattle. Mrs. Mason and three children, James Tate Mason, Mary Virginia Mason and Frederick DeWolfe Mason, survive him.

In 1917, Doctor Mason and his colleagues began the association which culminated in the Mason Clinic, and within two years they organized and built the Virginia Mason Hospital of which he was Chief Surgeon and President at the time of his death.

From 1923 to 1926 he served as Secretary of the Section on Surgery, General and Abdominal, of the American Medical Association, and was Chairman of that section for one year. Between 1928 and 1934 he was a member of the House of Delegates, and during the year prior to his death, he was active in fulfilling the obligations of President-elect of the American Medical Association. His death followed some five weeks after the unusual honor of his installation in absentia to the office of President.

In addition to his local societies, Doctor Mason was a regular attendant at the meetings of the Western Surgical, Southern Surgical and Pacific Coast Surgical Associations. He was a Fellow of the American College of Surgeons and was elected to membership in the American Surgical Association in 1930. He served as President of the American Association for the Study of Goiter and of the Pacific Coast Surgical Association.

His death occurred at the Virginia Mason Hospital in Seattle on June 20, 1936, the result of endocarditis with multiple emboli.

His affiliations bear witness to his lively interest in and enthusiasm for all things surgical, and to his executive ability as well. They can give no picture, however, of his love for people which was perhaps his outstanding characteristic. His companionability was felt by all, even though their contacts with him were brief. His adaptability, keen memory for faces and names, genial manner, ready speech and an inexhaustible fund of Southern stories, all combined to endear him to a huge circle of friends. Able surgeon, executive and administrator, friend to many, his death leaves a gap in the surgical profession.

HOWARD C. NAFFZIGER.